# ELECTRICAL REVIEW

SEPTEMBER 1955 PRICE 1s 6d



UNIVERSITY OF MICHIGAN

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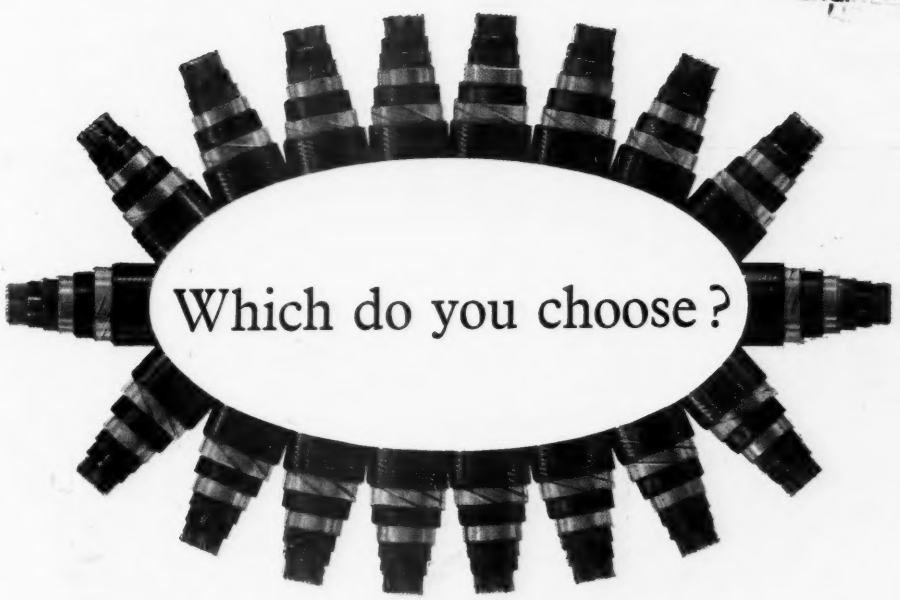
ENGINEERING



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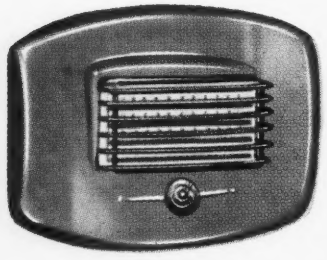

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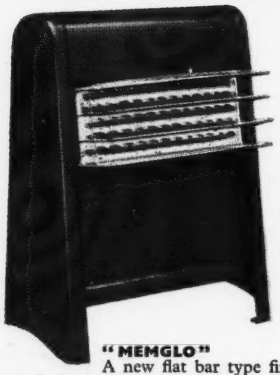

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# ELECTRICAL REVIEW

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9 SEPTEMBER 1955

## *In This Issue*

477 SIMPLIFYING THE ISSUE
479 ACTON LANE "B" POWER STATION
484 BRITISH ASSOCIATION MEETING
489 VIEWS ON THE NEWS
490 GOOD INSTALLATION PRACTICE
493 PERSONAL AND SOCIAL
495 INDUSTRIAL NEWS
498 AIRCRAFT ELECTRICAL EQUIPMENT
500 WORLD ELECTRICAL MARKETS—PORTUGAL
503 RAILWAY ELECTRIFICATION
505 RELAXATION SOLUTION INVOLVING REFRACTION
508 VARIABLE SPEED DRIVES
513 GERMAN ELECTRICAL COMPETITION
514 GENERATION AND DEVELOPMENT
515 NEW ELECTRICAL EQUIPMENT
516 FINANCIAL SECTION
520 NEW PATENTS
521 CONTRACT INFORMATION
522 NEXT WEEK'S EVENTS

VOLUME 157 ◇ NUMBER 11

*Eighty-Third Year of Publication*

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142 INDEX TO ADVERTISERS

**Editorial, Advertising and Publishing Offices:** Dorset House, Stamford Street, London, S.E.1. Telegraphic Address: "Elecrev, Sedist, London." Code: ABC. Telephone No. Waterloo 3333 (60 lines). Registered at the General Post Office as a Newspaper. Entered as Second Class Matter at the New York, U.S.A., Post Office. Annual Subscription: Home and Overseas £4 10s 0d: U.S.A. and Canada $14.00. Cheques and Postal Orders (on Chief Office, London) payable to ELECTRICAL REVIEW PUBLICATIONS LTD., and crossed "Lloyds Bank."

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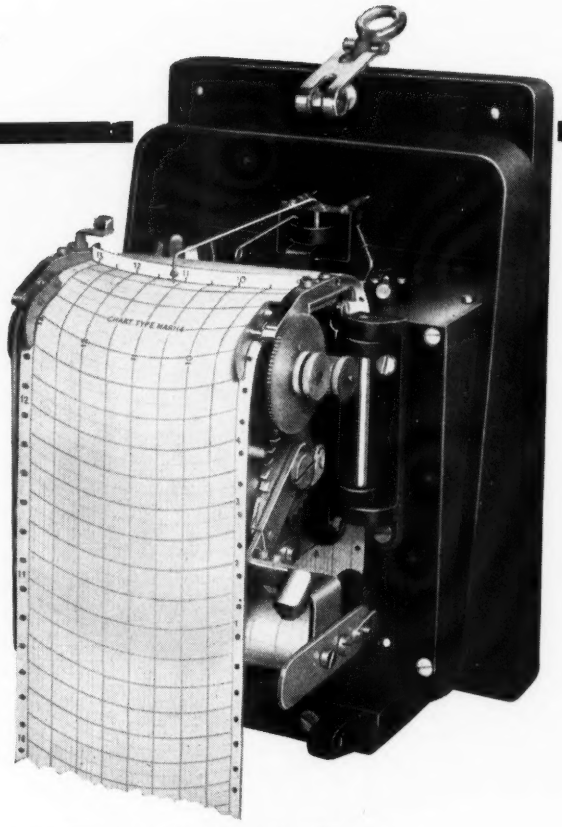

*Super Responsive Inkwell Graphic Milliammeter, projecting switchboard pattern, cover removed.*

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ELECTRICAL REVIEW

9 September 1955 Vol. 157 No. 11 Established 1872

# Simplifying the Issue

In 1882, the year of the first Electric Lighting Act, the Institution of Electrical Engineers published the earliest of the series of wiring regulations for securing the safe use of electricity, of which the thirteenth edition came into force at the beginning of this month. Although the hazards introduced by electrification are statistically minute, any preventable accidents ought, on principle, to be eliminated, and there are those who hold that compliance with these regulations should have statutory backing.

One difficulty of accepting this view is that the regulations have tended to become chiefly a guide to good practice, based in many instances upon recommendations of such bodies as the British Standards Institution or contained in Codes of Practice, adhesion to both of which is essentially a voluntary matter. There is also the question of penalties attaching to refusal by supply undertakings to connect consumers' installations which, while falling short of requirements, might be difficult to prove to the satisfaction of a Court of Law as " unsafe " in the strictest and most immediate sense of the word.

A way round these obstacles that gives some kind of equivalent to mandatory authority has been found in the 1955 edition, which has been re-cast throughout, by its division into two parts which draw a distinction between what is basically essential to safety and what in the mature consideration of experienced electrical engineers is the best means known for achieving that end without excluding the possibility of other as yet undefined methods for achieving the same purpose.

The first part was dealt with by us last week. The second part forms the subject of a further article in this issue. The most notable difference in technical aspects between the present and previous (1950) editions is in regard to cables and flexible cords, but the most important novel feature lies in the improved arrangement of the document as a whole and the greater directness and simplicity of its wording. This has been done without sacrifice, so far as we can see, of the meticulous precision necessary for citation of the document in contracts as supplementing statutory provisions.

The Wiring Regulations Committee has stated its willingness to assist users by interpreting the intended effect of any requirement. The expression " so far as is reasonably practicable " occurs on several occasions and any doubt in special cases should be referred to a professionally qualified electrical engineer. There is no intention, of course, that the regulations should take the place of detailed specifications. Still less are they meant to instruct untrained persons. Carefully thought out as the regulations clearly are, with the collaboration of supply authorities and other competent bodies, their effectiveness, as the Committee emphasizes, will depend on good workmanship.

## ELECTRIC RAILWAY CONSTRUCTION

In view of the major 15-year programme of reconstruction of British Railways which embraces a very considerable amount of main-line electrification, we think that the constructional work which we saw last week on the Chelmsford-Shenfield-Southend electrification (described elsewhere in this issue) may have a very special significance. A scheme has been developed whereby the excavating of the holes for the masts of the steel structures which are to carry the overhead conductors, placing the masts in position and concreting the footings are all done in a section of the line " in possession " in almost one continuous operation. The complete erection of 22 masts in this way in a period of only $4\frac{1}{2}$ hours certainly appears to be an excellent performance and the influence of such a scheme on the work involved in the larger programme, under which very much longer stretches of line are to be electrified, must be very considerable, especially in view of the likely difficulty of obtaining possession of long stretches of track for reasonable periods of time.

## SHORTAGE OF TECHNOLOGISTS

It is now four years since the Duke of Edinburgh as President of the British Association drew attention to the seriousness of the shortage of technologists in this country. Since then things have got worse, and in his presidential address to the British Association at Bristol last week, reported in this issue, Professor Sir Robert Robinson underlined this disagreeable fact. But why have things got worse? It is not because we have not been alive to the facts; the extent to which all concerned have talked about the problem shows this. Manufacturers have entered into fierce competition to obtain recruits for their training schemes; more places have been made available in the universities and colleges for technological students; higher grants have been made available and the pay of science teachers in the schools has been raised considerably. But so far there is little to show for all this. The real reason is, as we have said before, that the trouble is not being sufficiently tackled at its source, namely, the schools. Much more encouragement must be given to the schoolboy to join the ranks of the technologists if a calamitous situation is to be averted.

## PORTUGAL MAKES HEADWAY

It will be seen from an article in this issue by Senhors V. P. Cruz and E. Gentil Cordeiro (Lisbon) that the Portuguese Government is taking urgent steps to increase the country's power supply. Since 1951, when the installed plant capacity was raised by 60 per cent by the inauguration of stations erected under a six-year development plan, there has been a further steep rise. By the end of 1954 the total capacity was approaching 800 MW, against 350 MW in 1950. In the next ten to twenty years the addition of a further 1,100 MW is contemplated. A very large proportion of the work is going to various European countries; British concerns have made important contributions. The authors are somewhat critical of what we regard as a virtue in British equipment—substantial construction. Whether it would be wise to cut down to the standards of some competitors is questionable but some reduction may be forced on us. Once again longer delivery periods than those offered by some other suppliers are alleged against British manufacturers, but we believe that this is largely a continuing echo of the past and that conditions are improving.

## EXPORTS TO CANADA

Last week Sir Archibald Nye, British High Commissioner in Canada, said that he was very much concerned about the sudden fall of Canadian purchases in the United Kingdom. As a result Canada's favourable balance of trade with this country had further increased. Sir Archibald thought that the causes of the decline in our trade with Canada were American " high-pressure " sales methods, coupled with the closeness of the market to the United States, and delayed deliveries by British manufacturers. So far as electrical machinery, equipment and appliances are concerned there certainly has been a decrease, but so far it has not been serious. Last year electrical exports to Canada at £8,255,536 compared with £8,514,261 in 1953; in the first seven months of this year the figure was £4,072,273, against £4,151,830. Many electrical manufacturers, at any rate, have striven hard for Canadian trade and will no doubt continue to try to stay the decline.

## GAGGED AGAIN

We have always contended (we think with justice) that the extended use of electricity in the home is in the national interest. For one thing the domestic load is a useful counterpart to the industrial load, tending to ensure better use of costly power plant. For another, in times when married women are needed to reinforce our inadequate labour force in industry anything which eases their household tasks is to be encouraged. This is the justification of the publicity undertaken by the electricity supply authorities and we should have thought that they realized it. Unfortunately, it seems that they have persuaded themselves, or have been persuaded, that it is " patriotic " at the present moment to seriously curtail their publicity—a futile gesture so far as the national economy is concerned. So far as we can gather the gas industry is not following suit.

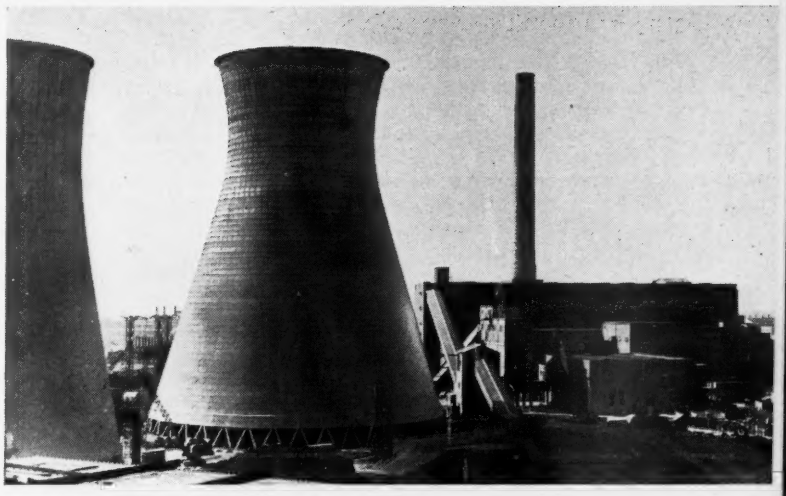
### SPECIAL LIGHTING ISSUE

Next week's " Electrical Review " (16th September) will be devoted largely to lighting subjects. In addition to a report of the annual conference of the Association of Public Lighting Engineers, it will include special articles on lighting developments, industrial and airport illumination, and illustrated notes on recent installations

1954 POWER STATIONS

# ACTON LANE "B"

## First 30 MW Set in Commission



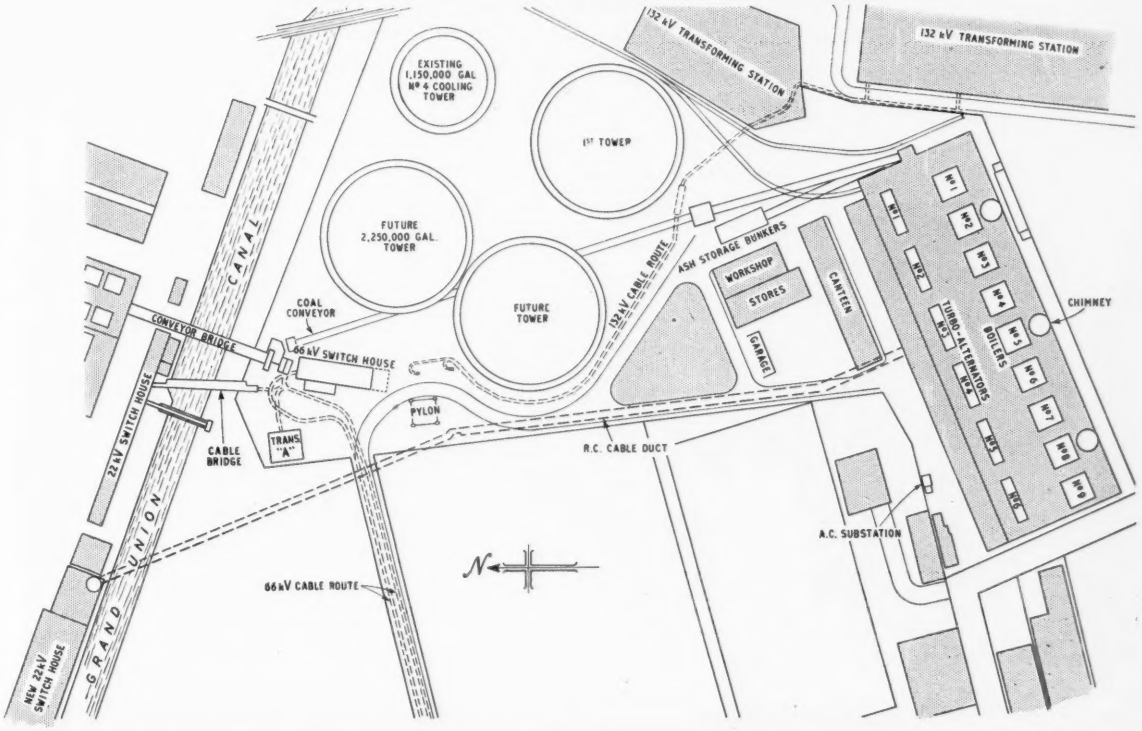
THE first of the six 30 MW turbo-alternators to be installed in Acton Lane "B" generating station in North-West London has now been in commission for some months feeding power into the 66 kV London grid network. The second set is planned to be on load some time during the next few weeks. At present the plant is being run mainly on the two-shift principle, but ultimately the intention is to go over to peak load operation only.

The station is basically of range design, there being three boilers to two generating sets and in accordance with modern practice there are no dividing walls between the turbine room and boiler house. The site is on the south bank of the Grand Union Canal and circulating water make-up is fed to the system from this source. The old "A" station, which dates back to 1897 and is eventually to be dismantled, is on the opposite bank of the canal. The site for the new station was largely the property of the original London Power Co., Ltd., so the difficulties often associated with land purchase were substantially obviated. Coal supplies to the station are exclusively rail-borne and the site also possesses good approach roadways.

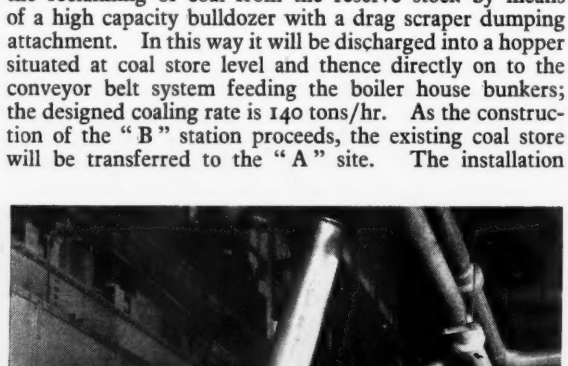
The main buildings are of conventional brick-clad reinforced concrete framed construction, running roughly east to west, and will ultimately be about 515ft long by 200ft wide, with three 300ft high reinforced concrete chimneys, a feature of these stacks being a venturi restriction towards the top which has the effect of increasing the discharge velocity of the gases. At present only one chimney has been erected and 325ft of the main building has been constructed, which is sufficient to accommodate the first three sets. The rest of the site is laid out as shown in the accompanying diagram.

As mentioned previously, all coal is delivered by rail, mainly from the East Midlands Division of the National Coal Board. At present a single 26in wide belt conveyor

*Site plan of Acton Lane "B" showing part of the "A" site to the left*

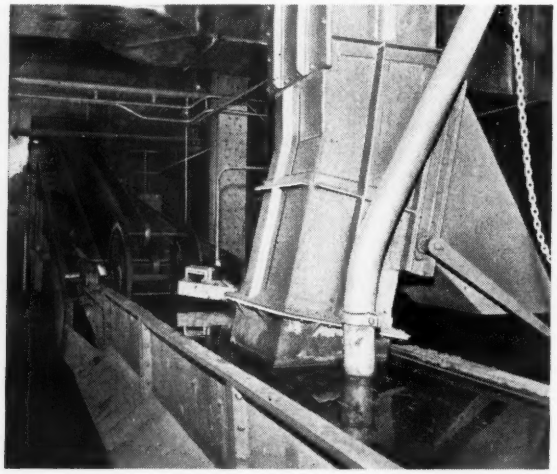


transports coal from the "A" site, where it is unloaded from the railway wagons by two existing wagon tipplers. In the 1957 programme a 140 tons/hr weighbridge and tippler are to be installed and provision will be made for the reclaiming of coal from the reserve stock by means of a high capacity bulldozer with a drag scraper dumping attachment. In this way it will be discharged into a hopper situated at coal store level and thence directly on to the conveyor belt system feeding the boiler house bunkers; the designed coaling rate is 140 tons/hr. As the construction of the "B" station proceeds, the existing coal store will be transferred to the "A" site. The installation includes an Avery 2-ton automatic weigher, through which all coal must pass en route to the bunkers. Coal sampling is carried out by means of a "Pullock" automatic conveyor belt sampler.



*The completed station will accommodate nine 240,000 lb/hr boilers*

*The main ash hopper empties on to a submerged belt conveyor*



## Boiler Plant

When it has been completed the station will accommodate nine 240,000 lb/hr boilers equipped with chain grate stokers, the steam conditions at the boiler stop valve being 625 lb/sq in and 875 deg F. The first contract provides for Mitchell boilers of the tri-drum type consisting of two steam and water drums and one water drum connected by bent tubes generally arranged in vertical banks, with certain of the tubes in the front banks almost horizontal to accommodate the superheater; the combustion chamber walls are completely water-cooled in the conventional manner.

Although the main framework of the boiler house is of reinforced concrete construction each boiler unit is suspended within its own steel framework so that all expansion will take place vertically downwards. The superheater is arranged in twin sections across the boiler, each section being complete with its own de-superheater for controlling the final steam temperature. Control of steam temperature is automatic and is of the George Kent air-operated type.

At the flue gas outlet of each boiler is fitted one Foster steaming type economizer, the arrangement being for gas flow downwards and water flow upwards. Water lancing is arranged for by the provision of suitable runways situated above each bank of tubes for the operation of retractable spray lances. Two Howden "Centicell" dust collectors, type 3 VS are fitted side by side between the economizer gas outlet and the air heater gas inlet. These collectors are in the form of a number of tubular cells, and the gas which passes axially along the tubes is given a spiral twist so that the dust particles are thrown outwards and pass through the outlet at the bottom of the tube. The clean gas moves into the central outlet tube and out of the chamber. The dust is precipitated into the hoppers beneath the collectors. Dampers are fitted at both the inlet and outlet of the collector.

The air supply to each boiler is through a Mitchell tubular type heater with the gas flowing downwards through the vertical tubes which are arranged in two banks, the upper tubes being 18ft long and the lower ones 8ft long. Both ends of these 2½in o.d. tubes are expanded into the tube plates for location and support, and in each bank the ¾in thick bottom plate is fixed and the ½in thick upper plate allowed to move freely upwards as the tubes expand. There is a seal around the edge of the moving plate to prevent gas leaking into the air path. The whole of the heater is supported on a robust frame with removable casing panels for maintenance access.

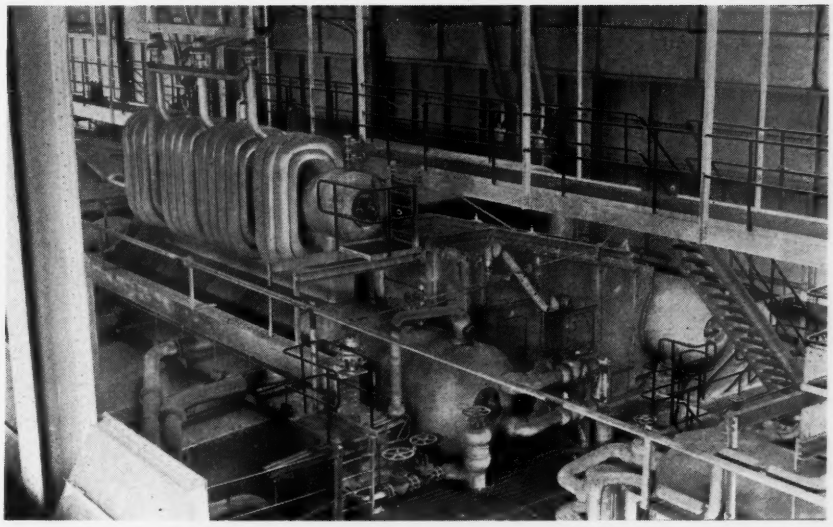
Each boiler is equipped with two induced draught fans of Howden manufacture each being driven by two-speed motors and having vane control. The fans are equipped with Lockheed hydraulic-electric manual remote operating gear. These fans are each designed for 72,000 cu ft/min with gas at 280 deg F and a static pressure of 13in water gauge. The motor speeds are 585 r.p.m. and 730 r.p.m. and their corresponding ratings 123 b.h.p. and 231 b.h.p. respectively.

There are also two Howden forced draught fans for each boiler and again each is driven by a two-speed motor and has vane control. Each fan also has a set of movable vanes in the fan inlet controlled by Lockheed hydraulic-electric manual remote operating gear. These fans are designed for 44,500 cu ft/min at 7in w.g. head and 80 deg F. The speeds are 580/720 r.p.m. and the driving

motor is rated at 41/79 h.p.

Secondary air is provided by two Howden constant speed damper control fans of the single inlet type designed for a volume of 10,000 cu ft/min at 13in w.g. pressure and 280 deg F. The speed is 1,440 r.p.m. and the driving motor is rated at 36 h.p.

Each boiler is fired by an Illinois "M" type twin span drop link stoker, consisting of twin grates, having a total width of 31ft and length of 24ft. The effective grate area is 744 sq ft. Each grate is driven by an Illinois 8-speed gearbox suitable for a 5 h.p. motor, 3 h.p. being required for the stoker drive and the other 2 h.p. for driving the scroll for the traversing chutes. The maximum speed of the grate is 72 ft/hr and minimum speed 14 ft/hr. Hoppers for catching riddlings and fine ash are situated beneath the stokers, the grits thus deposited being removed by the pneumatic dust extraction plant, or in case of emergency by chutes into barrows. The forced draught system is connected to the fine ash hopper which thus becomes a windbox. The coarse ash being deposited over the back end of the stoker is precipitated into the main ash hopper which in turn is emptied on to a submerged belt conveyor.



*No. 2 boiler from drum level*

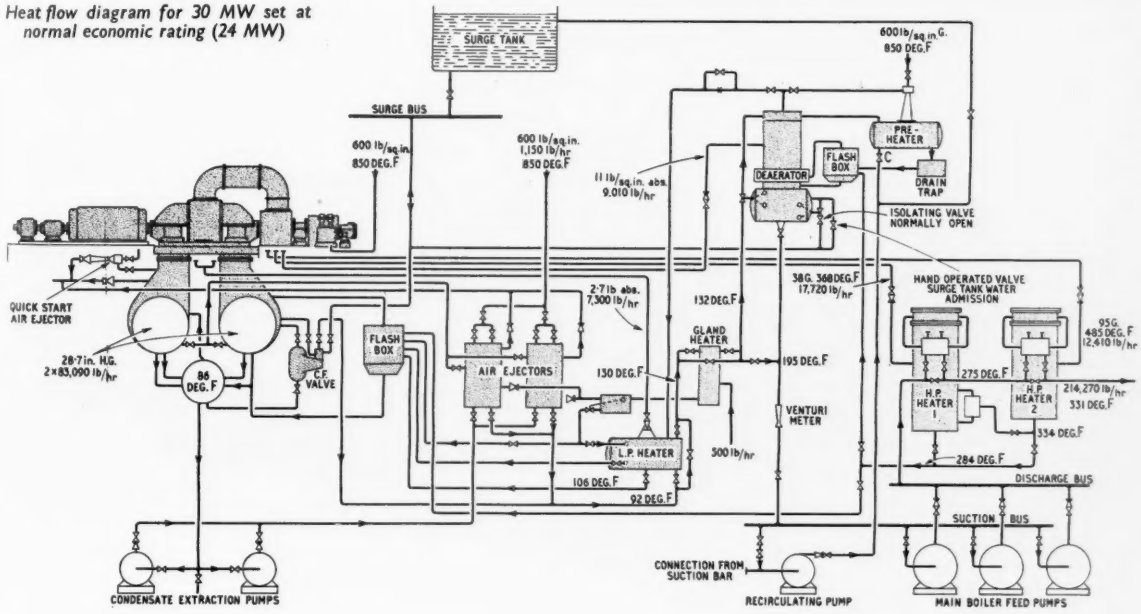
## Dust Extraction Plant

The Davidsons pneumatic dust extraction plant is capable of handling 8 tons/hr of dry free flowing dust of not more than 1in cube in size. The plant is designed for collecting the grit from the riddlings, and fine ash from the boiler, economizer, "Centicell" and chimney hoppers through conveyance mains to a large capacity storage bin in the annexe at the east end of the boiler house. The grits from the storage bin pass over a dust damping mixer conveyor driven by a 15 h.p. motor and are removed by road transport. The exhauster for this plant is installed in the basement and driven by means of an 85 h.p. single-speed motor running at 1,440 r.p.m. The boilers are fitted with electrically operated sootblower equipment utilizing steam at 625 lb/sq in and 865 deg F.

Clyde Blowers, Ltd., are supplying eight retractable single-nozzle blowers for the furnace tubes, four retractable single-nozzle blowers for the secondary superheater front portion, four retractable single-nozzle blowers for the primary superheater front portion, and four retractable single-nozzle blowers for the primary superheater rear portion.

All of these sootblowers are operated by means of remote control push-buttons from special cubicles, one of which is provided for each boiler and situated on the

*Heat flow diagram for 30 MW set at normal economic rating (24 MW)*



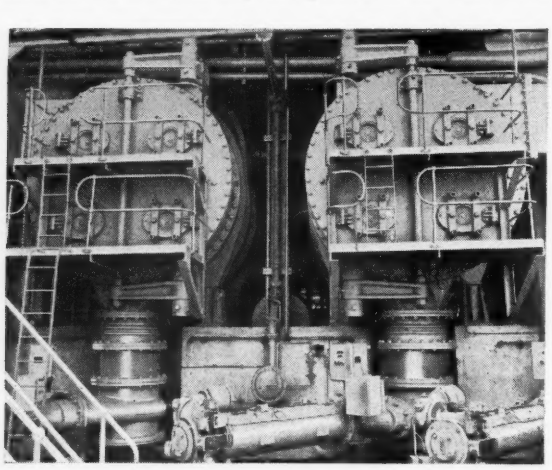
firing floor at the front and right side of the boiler. Illuminated signals on the cubicle show when each blower is in action.

The 3,000 r.p.m. turbo-alternators so far installed are being supplied by Richardsons Westgarth, Ltd., each unit having a maximum continuous rating of 30 MW and a normal economic rating of 24 MW. The design terminal conditions are 600 lb/sq in and 850 deg F at the turbine stop valves with 28·5in Hg and a final feed temperature of 345 deg F.

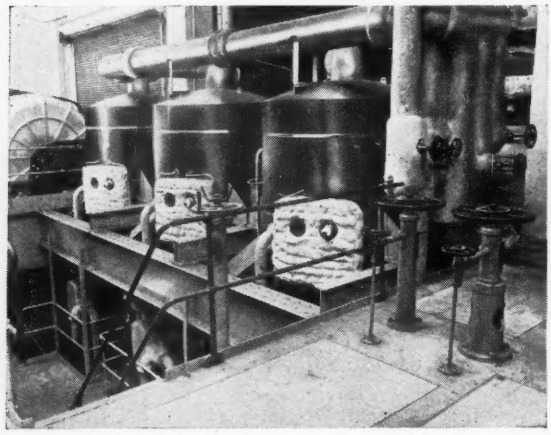
The turbines are three-cylinder units of the impulse reaction type with the three cylinders arranged in simple tandem. The h.p. cylinder has one row of impulse and 23 rows of reaction blades, while the i.p. cylinder has 18 rows of reaction blades and the l.p. cylinder two groups of five reaction rows of blades in parallel. The turbines are arranged longitudinally down the turbine room.

## Condensers and Feed Heaters

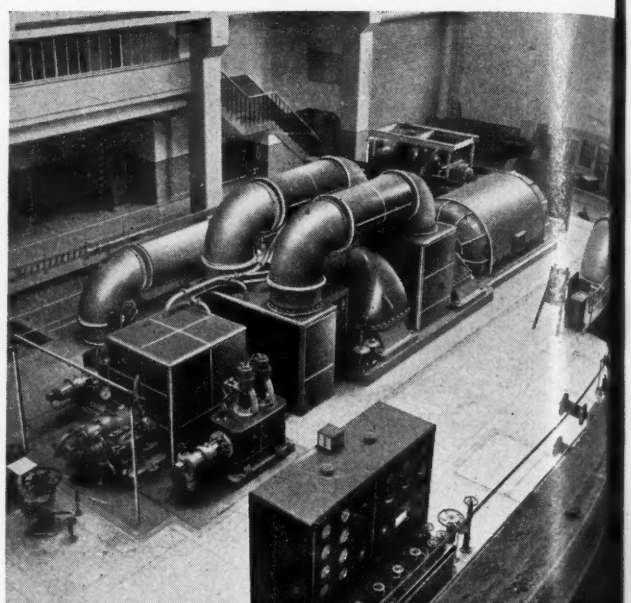
Twin condensers of Richardsons Westgarth manufacture are provided for each turbine. They are of the two pass type and the total cooling surface is 27,000 sq ft (13,500 each), the design circulating water temperature being 65 deg F. The tubes are of Admiralty mixture, 1in o.d. 18 s.w.g. and 18ft long, the tubes being expanded at the inlet ends and cotton stay lace packed at the outlet ends.



*The twin condensers for each set have a total cooling surface of 27,000 sq ft*



*The three feed heaters associated with No. 1 set*



*No. 1 set has been in commission for some months now*

The condensate is extracted from each condenser by two 100 per cent duty electrically driven extraction pumps.

The feed heating and de-aerating system is of the Richardsons Westgarth closed type, capable of raising the total condensate to 345 deg F at the outlet from the second h.p. heater when the unit is developing maximum continuous rating and the heaters and de-aerator are supplied with steam at four different pressures from the bled steam connections on the turbine cylinders as shown in the accompanying heat flow diagram. The combined de-aerator and i.p. heater is designed for a maximum flow of 320,000 lb/hr with a maximum heating steam pressure of 15 lb/sq in absolute and a guaranteed oxygen content under steadily maintained operating conditions of 0·01 c.c. per litre at the de-aerator outlet. Feed water make-up is provided by a base exchange water softener of Filtrators, Ltd., manufacture, the softened water being evaporated in Weir triple-effect evaporators. The supply of feed water to the boilers is controlled by a Copes " Flowmatic " regulating system.

One Drysdale vertical spindle circulating water pump of 1·5 million gal/hr capacity against a generalized head of 65ft at full load is provided adjacent to each machine in the basement. The final installation will consist of three 2·25 million gal/hr concrete cooling towers, 250ft in height, together with one 1·5 million gal/hr existing concrete tower, which has been modified complete with anti-precipitation louvres and the irrigation level has been raised to bring it into relationship with the new towers. Cooling water make-up is drawn through a rotary bracket screen from the Grand Union Canal by means of two Worthington-Simpson centrifugal pumps rated at 1,667 gallons an hour.

A Wallace & Tiernan master visible vacuum type chlorinator has been installed equipped with fully automatic control. The capacity of the chlorinator is 2,000 lb/24-hr continuous rating and it is designed for dealing with the ultimate chlorination of six sets.

Each of the 3,000 r.p.m. alternators generates at 11·6 kV the full load being 33·333 kVA at 0·9 power factor. Cooling is by means of a closed air circuit, the outlet air

being passed through a nest of tubes cooled by circulating water in the conventional manner before being re-circulated through the machines. The cooling air for each alternator is circulated by two fans each driven by a 150 h.p. 415 V three-phase motor. The exciter is directly coupled to the main shaft of the alternator and voltage control is effected by means of a B.T.H. automatic voltage regulator. A 3 MVA 11·6/3·3 kV unit transformer is directly connected to the alternator terminals and feeds on to the 3 kV house service board through a 600 A ironclad vertical isolation switch.

The first turbo-alternator and a 33 MVA 11·6/22 kV step-up transformer couples the station to the 22 kV busbars through Ferguson Pailin type V.D.P. 36 circuit-breakers with a rupturing capacity of 500 MVA. These are of the vertical isolation metalclad, duplicate busbar design and provision has been made for extension when required. The 22 kV busbars are connected to the 66 kV grid network by means of two 40 MVA 22/66 kV transformers and 40 MVA cast-in-concrete reactors.

The main 22 kV switchgear is segregated into four sections with intervening 30 MVA reactors, a special feature of the gear being that duplicate circuit-breakers are housed in a common oil tank. The major auxiliary switchgear operates at 3·3 kV and is fed by 6,000 kVA step-down transformers from the 22 kV switchgear. The 3·3 kV switchgear is of South Wales Switchgear manufacture and is oil insulated. The feed pump and circulating water pumps are wound for 3·3 kV operation.

The turbine and boiler house 415 V auxiliary switchboards are fed via 1,500 kVA and 750 kVA step-down transformers from the South Wales 3·3 kV house service board and are of Brookhirst manufacture being of the air-break contactor type, protected with h.r.c. fuses. The main requirements of each boiler and turbine are supplied from unit switchboards the feeds for which are taken from the house service board.

The London and Southern Electricity Boards are supplied through a group of 20 feeders controlled by a bank of Ferguson Pailin type V.D.P. 36, 500 MVA rupturing capacity, vertical-isolation, duplicate busbar oil circuit-breakers.

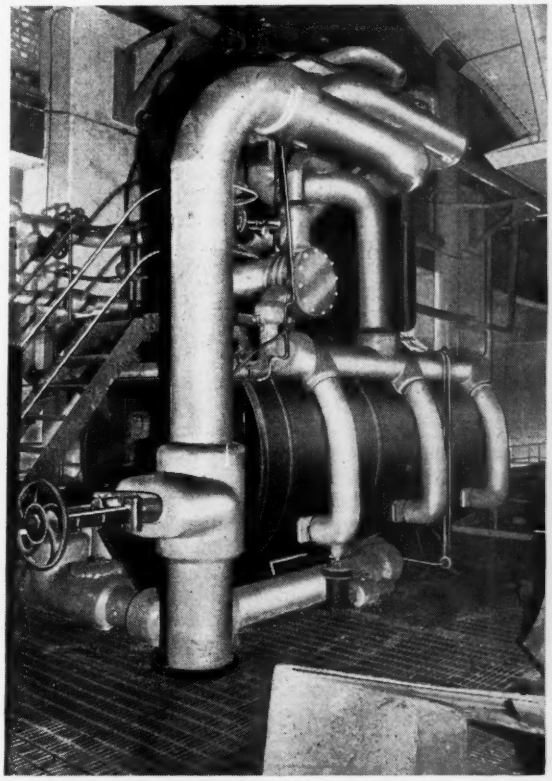
*Mr. R. H. Dobson, the station superintendent*

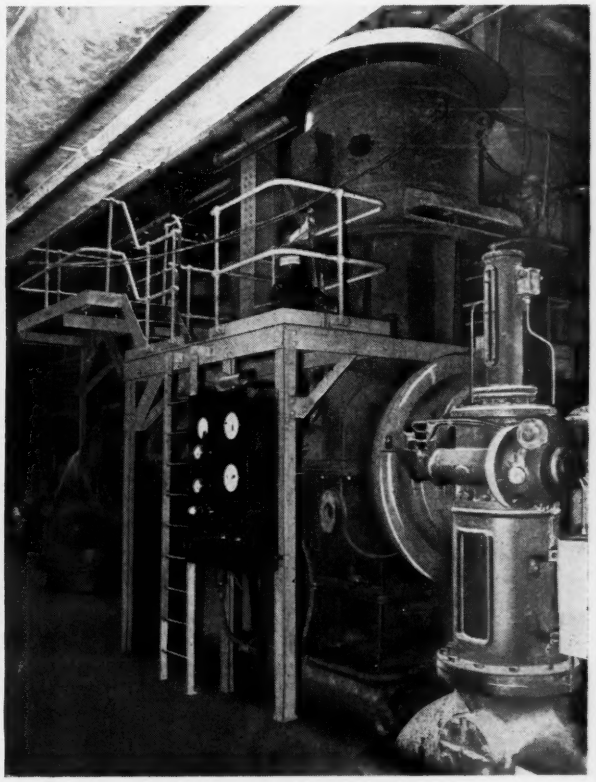
No consulting engineers were employed for the construction of the station; all civil engineering and plant design work is being carried out by the London Division of the Central Electricity Authority.

The main contractors for the plant are:—Civil engineering works, Sir Robert McAlpine, Ltd.; boilers, Mitchell Engineering, Ltd.; turbo-alternators, Richardsons Westgarth, Ltd.; coal-handling plant, Naylor Bros., Ltd.; submerged ash conveyor, John Thompson, Ltd.; pneumatic dust extraction plant, Davidson & Co., Ltd.; main step-up and house service transformers, Ferranti, Ltd.; station auxiliary transformers, South Wales Switchgear, Ltd.; 22 kV switchgear, Ferguson Pailin, Ltd.; 3·3 kV switchgear, South Wales Switchgear, Ltd.; cooling towers, J. L. Kier & Co., Ltd.

Acknowledgment is due to Mr. H. V. Pugh, Divisional Controller, London Division, Central Electricity Authority, for permission to publish this article and to Mr. R. H. Dobson, superintendent of Acton Lane "A" and "B," for invaluable assistance in the preparation of the material.

*Left: The combined de-aerator and i.p. heater is designed for a maximum flow of 320,000 lb/hr. Right: One 1·5 million gal/hr circulating water pump is provided for each set*





# The British Association

## PROCEEDINGS AT THE BRISTOL MEETING

THE inaugural meeting of the 117th annual meeting of the British Association for the Advancement of Science was held in the Colston Hall, Bristol, on Wednesday, 31st August. The meeting was preceded by a ceremony at which the vice-chancellor of Bristol University, Sir Philip Morris, conferred the honorary degree of D.Sc. upon Sir Robert Robinson, president of the British Association, and Professor N. F. Mott, Cavendish Professor of Physics at Cambridge University.

In his presidential address Sir Robert Robinson said that people must not allow the horror of the possible misuse of the hydrogen bomb to blind them to the spectacular triumph of the achievement. It showed very plainly that nuclear physicists had been thinking on the right theoretical lines. These matters were shrouded in secrecy, but Press reports had suggested that just as the hydrogen bomb was initiated by a Mark-I atomic explosion, so the hydrogen bomb in its turn could initiate a vastly greater uranium explosion. In biological processes energy was taken up in steps by suitable relays to high levels, and an ordinary scientist could not help wondering whether every possibility of setting fire to the lighter elements had quite certainly been excluded, if nuclear relay was taken to further stages.

Did we really know enough about nuclear reactions to be sure there was no loophole? Had every conceivable case been considered? Physicists were sure that this was so. But just as it was necessary that " justice shall be seen to have been done " Sir Robert submitted that it was desirable that the inner circle of advisers to Governments should not only be right but be " seen to be right." This could only be secured by a relaxation of secrecy on the scientific aspects of nuclear energy developments and by some form of international consultation before novel and greatly increased releases of energy were attempted.

In a reference to technology and technologists, Sir Robert said that it was generally agreed that we had far too few technologists in this country and that our economic survival was improbable unless some drastic steps were taken to remedy the situation. The proposals that had been made were admirable so far as they went, but, in the opinion of many who were well qualified to judge, they did not go nearly far enough. It was doubtful whether any scheme tied to existing institutions could meet the requirements. He suggested that there was need for a Technology Grants Committee, independent of any other body and with power to expend a very considerable sum of money. This idea had probably already been adumbrated, in which case he thought it should be supported.

### Ship Propulsion and Auxiliaries

At the first meeting of Section G—Engineering, on 1st September, the president of the Section, Dr. S. F. Dorey, gave an address on " The Influence of the Engineer on Sea Transport and Trade." After reviewing the developments of main machinery installations over the past 150 years, Dr. Dorey referred to the construction of two submarines for the U.S. Navy in which the heat developed in a nuclear reactor was used to raise steam for supplying both main and auxiliary turbine machinery. This had resulted in wide speculation on the possible adoption of similar power plants for merchant-ship applications. Such an impressive statement as that the fissioning of 1 lb of uranium produced heat equivalent to 2,300 tons of coal or 300,000 gal of oil raised visions of revolutionary changes in the design of merchant ships and their machinery. As these changes would solve many existing problems, it seemed that thermal reactors must eventually provide the energy for steamship propulsion. When this event would be possible depended on the rate of progress made in reducing to more attractive levels the weight, size and cost of reactors and screening, and the satisfactory solution of control and maintenance problems. It appeared that the power/weight ratios of these units would be better suited to the higher-powered plants of large cargo and passenger liners than to the many low-powered installations in smaller ships. Undoubtedly the latter would continue to be driven by conventional prime movers.

While the developments of main machinery installations in little over 150 years had made a substantial contribution to the expansion of world trade, auxiliary machinery had also played a part. The luxury of a modern liner stemmed, in part, from this source. It was just over 75 years ago that Inman had first employed electricity on board ship to supply arc lamps fitted in the saloon of the *City of Berlin*. From that time the applications of electricity had increased markedly and the size of the d.c. generating plant had grown to meet these needs. In more recent years a.c. systems had become prevalent in both oil tankers and passenger liners. In addition, diesel-driven generators had largely superseded those of steam reciprocating engine-driven types.

Large liners invariably employed steam turbines for both main and auxiliary purposes, but the installation in the Greek liner *Olympia*, completed in 1953, had departed from this practice by employing steam turbines for main propulsion only, the auxiliaries being exclusively diesel-electric. In cargo ships a new departure had been the use of a free piston gas generator supplying the gas turbine of a turbo-electric set and a number of normal gas-turbine sets were now under construction and would soon be in service at sea.

### Production Statistics

In a contribution entitled " Trends in Production and Productivity," Mr. K. S. Lomax, Senior Lecturer in Economic Statistics, Manchester University, gave an account of the work being done at Manchester University on the analysis of trends in production and productivity in the United Kingdom in the last 50 years.

The work was being divided conveniently into sections under three headings: (1) production, or output; (2) input; and (3) productivity, this being the relationship between output and input. On output, they were constructing index numbers of the physical volume of production industry by industry and groups of industry and for all industry in the United Kingdom in three periods: 1907-20, 1920-38, and 1938 onwards.

Attention was being given to various alternative possible calculations, such as the effect of different weighting systems. They were also examining the differences

between the conventional method of calculation of index numbers compared with alternatives, such as that associated with the name of R. C. Gibb, and the effect of different industrial classifications.

On the input side, they were looking at all inputs—employment, movements in employment and man-hours annually for the different sections of industry; capital, e.g., changes over the period in capital investment and the volume of capital in different industries; raw materials, e.g., an analysis of changes in raw material usage in different industries. Finally, there was an analysis of changes in productivity, and in particular labour productivity, in different industries over the last fifty years.

## Power from Nuclear Fuel

On Friday, 2nd September, Dr. J. V. Dunworth, of the Atomic Energy Authority, addressed Section G on the methods of using fuel in a nuclear-power programme. He said that there were hundreds of types of reactors that could theoretically be built, but that the crucial test was an economic one. There were two types of uranium; U235 and U238. The first was a natural fuel and occurred to the extent of one part in 140. The U238 atoms could be used for making fresh fuel if they were placed in a pile.

One of the things that could be done was to separate these two types of atom to get a pure fuel free of U238 atoms. Since these two atoms were alike chemically, it was necessary to work on some process other than a chemical one, and the most economical plant which had so far been built for this purpose was a diffusion plant. To give an idea of the scale of operation in this field, America had built diffusion plants which used almost as much electricity for this purpose as the entire consumption of electricity in Great Britain.

Natural uranium could also be put into a pile that was capable of working with it. Of the tremendous number of piles, there were only two which were likely to work at all economically with natural uranium, one of them using graphite as a moderator and gas for cooling, and the other being cooled and moderated with heavy water under pressure. In building a pile which worked on natural uranium, a pure fuel was produced, because the U238 in it was converted into plutonium.

As soon as pure fuel was obtained there was complete freedom to tackle the question of the different types of pile. That was the very interesting stage that had now been reached in this country—what was to be done with the pure fuel that was going to be made. It had already been announced that a small fast reactor had been built at Harwell, and a large fast reactor was being built at Dounreay. So far the Authority had not announced what was to be done in the thermal reactor field.

In considering this field, there were four moderating atoms: beryllium, carbon, heavy hydrogen and light hydrogen, and for early use the state of development was such that it was necessary to limit the coolants to gas, heavy water, light water, and sodium. Beryllium was fairly expensive and there were no facilities on an adequate scale for making it, so that it was ruled out completely. Carbon was a good moderator and could be used with gas cooling. To use any form of water cooling with graphite was probably not good. Initially, thought was in the direction of using graphite moderation with gas cooling, with a possible development towards the employment of sodium cooling.

In reply to questions, Dr. Dunworth said that there had been a great deal of misunderstanding about the radioactive waste substances from nuclear reactors. He estimated that the room in which he was speaking, the lecture theatre in Bristol University Engineering School, could contain all the waste products from the British nuclear power programme during the next 100 years. There was no reason why any of them should escape into the atmosphere. The amount of uranium needed each year to make possible the present annual increase of installed nuclear power in Great Britain was six tons.

To a question about the probable life of reactor equipment, Dr. Dunworth replied that the reactors could have a very long life, comparable with that of normal power plants. The old idea that the equipment could not be maintained had gone; the technique of maintenance was rapidly being learned and would give to the equipment a life that would be limited only by obsolescence.

Mr. H. H. Gott, also of the Atomic Energy Authority, then spoke on the design and operation of power producing reactors. After describing the design of a reactor of the Calder Hall type, he said that the problem of power production was not simply that of extracting heat from the reactor. It was necessary to get the heat out at as high a temperature as convenient. To decrease the power used in circulating the coolant would mean increasing the diameter of the cooling channels, thereby reducing the velocity of gas over the fuel elements. But this would mean running the risk of decreasing the temperature rise in the reactor.

The reactor must be run in such a way as to get the coolant out at the maximum temperature consistent with economic pumping of the coolant round the circuit. The sort of thermal efficiency that was thought about in plants of this sort was of the order of 25 to 30 per cent, before subtracting the power required for blowers, which would reduce the efficiency by something like 5 per cent.

In reply to questions and comments, Mr. Gott said that the efficiency figure he had quoted was the overall efficiency, including the steam generating plant. To a question about the amount of electricity used for making the fuel used, he replied that the amount was quite small. Much power was used in the separation of isotopes and the concentration of U235 from natural uranium, but the amount of power that went into the Springfields factory, where pure uranium was produced from uranium ores, was not very large considering the output of the factory. This was why it was preferable to use natural uranium for reactor construction; it involved ordinary chemical processes and there was only the electric power consumption which was necessary for melting furnaces, pumps, and so forth.

## Training Technicians

In Section L (Education), Dr. J. E. Richardson, principal of the Northampton Polytechnic, London, delivered a paper entitled "The Training of Technicians for the Automatic Age: the Contribution of the Technical College."

The results of automation on industrial personnel, said Dr. Richardson, would probably involve an increase in the number of supervisors and junior executives, with altered functions. There would be more in charge of machines than of men, of whom there would be few; they would be less like foremen and more like shift engineers in ships or in an electric power station. Although there would be fewer workers on the floor, there would be a greater need of understanding between the supervisors and those few.

Dealing with the future provision that would be necessary in technical colleges, Dr. Richardson said it was clear that an overwhelming preponderance of technicians would be required. This was recognized not only by contributors to the Margate Conference organized by the Institution of Production Engineers in June of this year

but by many forward-looking bodies in the field of technical education.

Another clear issue was that while technicians' courses must be narrowly specialized, increasing regard must be paid to the correlation of fields of interest. If technicians were in narrow ruts, they must be given a look into adjacent ruts. This would mean an even closer integration between departments. Hitherto the work of the colleges had been broadly that of teaching men the technology of the work they were engaged in, but now it was to become teaching men to understand and maintain the " gadgetry " behind the machines that did the work they had once done.

He did not anticipate any great difficulty about the availability of youngsters with the right educational background for training for the new age. The demand for boys with G.C.E. advanced level qualifications in science subjects would undoubtedly be high and more would be required in industry than ever before. The technical colleges, except for the larger ones with courses recognized for the new diplomas in technology, would not in his opinion be short of students for technician courses.

The colleges would, however, have to meet a changing emphasis, and for this they would probably need large laboratories for pilot plant; smaller laboratories for specialized training—equipped generously and with the latest " gadgetry," possibly on loan from industry; a closer integration with industry, by operating sandwich courses (the students being industry-based), by generous interchange of staffs between college and industry, and by industrial representation on governing bodies of colleges; generous financial provision; a more rational scheme of organization of technical education; and adequate salaries to ensure that the best men would remain on college staffs.

In the discussion, one speaker suggested that the first industrial revolution had given machines the skill and men the dull, monotonous work, but with automation it would be the reverse—machines would do the dull, monotonous work and men the more skilled work of watching the machines.

Another speaker suggested that the real question was whether the introduction of automation would reduce the ever-increasing demand that industry was making for intellectual ability. For instance, in the present century the industries connected with electricity, and other industries, had made colossal demands for workers of the highest intellectual ability, and there were hundreds of jobs for which suitable youngsters were not available.

## Metallic Structure

In his presidential address to Section A on " The Physics of the Solid State," Professor N. F. Mott, F.R.S., Cavendish Professor of Experimental Physics, Cambridge, dealt with the problem of self-diffusion in solids, particularly in metals, and discussed the concept of a vacant lattice site in a crystalline solid. He showed how this affected ordinary processes of metallurgy, the behaviour of materials in reactors and, finally, the relation it might have to the urgent and important problem of metallic fatigue.

Referring first to the concept of a vacant lattice site in a crystalline solid, he said that if two metals were put together and heated sufficiently, it was well known that they would weld together, an intermediate region forming occupied by an alloy of the two metals. This meant that when the crystal lattice of a metal was occupied by two different kinds of atoms, it was possible for them to change places, and if two atoms of different kinds could change place, one could say *a fortiori* that atoms of the same kind could change their places too. This progress was known as self-diffusion.

On the general question of radiation damage, which the development of nuclear reactors in which the materials were continually subject to heavy radiation had made an important and fashionable subject of research, Professor Mott said that the effects of radiation damage were various. After irradiation, the diffusion of one metal in another was accelerated, and this seemed to indicate that the vacancies were indeed formed and that they could move about in the metal, and that the vacancy model of diffusion was the correct one. Also the strength and density were affected.

A property much investigated, on account of the ease with which small changes could be detected, was the electrical resistance. Just as impurities increased the electrical resistance of copper or of most other metals, presumably because the presence of vacancies or of interstitial atoms acted just like impurities, so the electrical resistance provided a good measure of the damage to which a metal had been subjected. A good deal more research would have to be done before these effects could be sorted out for certain.

A possible effect of the vacancies and interstitials, more speculative but perhaps more important, was the phenomenon of fatigue. Metals broke sometimes after tens of millions of applications of an alternating stress. The crack first formed quite early on in the test and slowly spread, and it first formed along a slip line. It seemed extremely probable that the material in a slip zone remained rather prone to slip. If in a fatigue test slip was occurring backwards and forwards in both directions in some of the slip bands, there would be a continuous production of vacancies and interstitials in these slipband regions, and the material would become gradually disordered, more and more atoms being pushed out of their proper positions. Now it was not, of course, clear that an intense disordering of the crystal would lead to fracture; it was hard to escape the conclusion that the material would expand locally, that great stresses would be set up, and local cracks result.

This was all very speculative, Professor Mott concluded. A theory of fatigue in terms of atomic movements was yet to be worked out; but the concept of a vacant lattice site in a crystal lattice had very wide applications in physics.

## Geophysical Year

Professor S. Chapman, F.R.S., formerly Professor of Natural Philosophy, Manchester, London, and Oxford, and now chairman of the International Committee appointed by the International Council of Scientific Unions, to be responsible for the organization of the International Geophysical Year, spoke to Section A on the objectives and scope of the I.G.Y. He gave an account of the historical background and the conception of the I.G.Y. and the way in which it is being organized.

The title " International Geophysical Year " covered the whole programme which had been discussed internationally and would be executed by the different nations according to their own free will and judgment. A total of £30 million would be spent by the whole world on this project, and the British share would be £650,000, of which £200,000 would go for the Antarctic Expedition and £100,000 on rockets.

Further information on the British plans for direct research on the upper atmosphere by rockets was given in a paper by Dr. R. L. F. Boyd, Lecturer in Physics, University College, London, in Section A. Experiments to be undertaken with rockets would include the use of the mass spectrometer, with which electrically charged particles present in the upper atmosphere could be sorted out according to type and the quantities of each estimated. When fully developed, the rockets were expected to reach a height of about 130 miles, which would enable most of the more interesting regions of the atmosphere to be observed.

In an interview later, Professor Chapman said that one

experiment which it was hoped to make consisted in letting loose in the atmosphere at considerable height a quantity of sodium vapour. There was metallic sodium vapour in the upper atmosphere which was luminous, and about which there were conflicting theories as to why it remained luminous. If some sodium were put into the atmosphere artificially, he said, the observation would tell something about the process of recombination and the mechanism by means of which this light was emitted from the upper atmosphere.

The President-elect of the British Association, Sir Raymond Priestley, later said at a Press conference that, in view of the advent of the International Geophysical Year, he hoped to make the history of the past half-century's exploration of the Antarctic the subject of his presidential address at next year's meeting.

# UNIPEDE CONGRESS

## *First London Meeting*

THE tenth congress of l'Union Internationale des Producteurs et Distributeurs d'Energie Electrique (International Union of Producers and Distributors of Electricity), commonly known as "UNIPEDE," opens in London on Monday, 19th September, under the presidency of Lord Citrine, chairman of the Central Electricity Authority.

UNIPEDE, which has its permanent secretariat in Paris, was founded in 1925 and is an association of organizations which, in each country, represent the interests in that country of producers and distributors of electricity. It is concerned with general economic and engineering problems of electricity supply and with international transfers of electricity and the compilation of international statistics.

The Congress meets every third year in one of the European capitals and this is the first time it has met in London. It is anticipated that there will be over 1,000 delegates and visitors, representing the interests of producers and distributors of electricity in the principal European countries.

On the Monday morning, at the Central Hall, Westminster, the delegates and their wives will be welcomed by Lord Citrine and Councillor P. Stirling, Mayor of Westminster. Mr. Geoffrey Lloyd, Minister of Fuel and Power, will then open the first session at which an address will be given by Sir Christopher Hinton, managing director, Industrial Group, United Kingdom Atomic Energy Authority. In the evening there will be a reception at the Guildhall attended by the Lord Mayor.

The working sessions of the Congress, lasting four days, will be held at Church House, Westminster, and will be devoted to the presentation and discussion of a large number of papers covering thermal and hydro-electric generation, atmospheric pollution, distribution, tariffs, statistics, and protection of telecommunications.

In connection with the Congress, three study tours in England and two in Scotland have been arranged for the delegates, who, in separate parties, will visit places of technical interest including steam and hydro-electric power stations, substations and distribution installations and also places of general historical interest. Visits have also been planned to other places of electrical and general interest, in and around London, including the C.E.A. Research Laboratories, Leatherhead.

The following are the reports to be dealt with by the various committees of UNIPEDE:—

**Thermal Generation Study Committee.** Chairman: G. R. Peterson (Great Britain). "General Report of the Committee," by G. R. Peterson; "Combined Coal-Oil Fired Stations," by Robert Boudrant (France); "Use of Thermal Power Station Ash," by Georges Van Antro (Belgium); "Experience with the Use of Slag-Tap Methods of Firing," by Dr. Ludwig Spennemann (Germany); "Atmospheric Pollution Arising from Power Station Operation," by G. R. Peterson and Dr. H. E. Crossley (Great Britain); "Power Stations and the Effluent Problem," by G. R. Peterson and F. F. Ross (Great Britain); "Starting of Boilers and Turbo-Alternator Sets," by Jean Ricard (France).

**Hydro-Electric Generation Study Committee.** Chairman: Dr. Claudio Marcello (Italy). "Study of the Part that Hydro-Electric Power will Come to Play in the Future Load Curve, due to the Progressive Exhaustion of Hydro-Electric Resources," by Charles Aeschimann (Switzerland); "The Evolution of River Development Schemes in Relation to Recent Progress in Underground Construction Methods," by Dr. Carlo Semenza (Italy); "Evolution in Dam Construction and its Effects on Cost and Quality of Energy," by Dr. Claudio Marcello; "Nature and Method of Operation of Steam Power Stations used for Equalizing Water Power," by Georges Bardon (France); "The Present Position of the Investigations and Results on the Forecasting of Run-off and Hydraulic Productibility at Electricité de France," by Stephane Ferry (France); "The Economic Value of Small Reservoirs taking into account the type of Load Curve and the part of Thermal Generation in the Supply," by Dr. Werner Pietzsch; "New Developments in Low-head Power Station Projects," by Marcel Mary.

**International Interconnections Study Committee.** Chairman: Professor Giovanni Silva (Italy). "General Report of the Chairman of the Committee," by Prof. G. Silva; "The Problem of Frequency and Power Transfer Regulation," by Francois Cahen (France); "Economic Comparison between the Transport of Coal and the Transmission of Electricity," by Roger Conrad (France).

**Distribution Study Committee.** Chairman: Dr. Erich Schulze (Germany). "The Voltage Trend in Distribution Systems," by Pierre Gaussens (France).

**Tariffs Study Committee.** Chairman: Charles Aeschimann. "Current Problems concerning Electricity Tariffs," by Gabriel Dessus (France); "General Report of the Working Group on Trinominal Apportionment of Costs," by Marcel Dulait (Belgium).

**Optimum Utilization of Electrical Energy Study Committee.** Chairman: Eric Tiberghien (Belgium). "General Report of the Chairman of the Committee," by Eric Tiberghien; "General Report on the Development of Domestic Applications of Electricity from 1950 to 1953," by Jacques de Felice (France) and Eric Tiberghien; "Organization and Operation of the Domestic Electric Appliance Market," by J. de Felice and Eric Tiberghien; "Credit-Trading Policy as Applied to Apparatus and Installation Extensions," by J. de Felice and E. Tiberghien; "General Report on the Study of Relationships between Standard of Living and Domestic Consumption of Electricity," by J. de Felice; "The Development of Electric Lighting in Italy," by Dr. Marcello Rodino di

Miglione (Italy); "The Application of Electricity to the Cooking of Food in Swiss Households," by Josef Blankart (Switzerland); "Domestic Water Heating by Electricity in the Federal Republic of Germany," by Dr. Kurt Halbach (Germany); "Commercial Organization of Area Boards in Great Britain," by E. A. Fowler (Great Britain); "General Report on the Level of Utilization of Electrical Energy in Industry," by J. de Felice and Eric Tiberghien.

**Statistics Study Committee.** Chairman: Dr. W. L. Froelich (Switzerland). "Statistics and Statistical Methods in the Electrical Industry General Report of the Committee," by Dr. W. L. Froelich; "General Report of the Working Group on the Investigation of Load Curves and Diversity Factors," by R. Y. Sanders (Great Britain); "Further Work in Connection with the Influence of Weather Conditions on the Paris and Paris Region Networks," by E. Vedere (France); "Influence of Weather Conditions on the Maximum Demand in the Hamburg District," by H. H. Nissen (Germany); "The Influence of Atmospheric Conditions on the Consumption of Electrical Energy in the Netherlands," by W. J. A. Kuipers and A. W. Zuidweg (Holland); "Effect of Temperature on the Consumption of Electrical Energy," by Louis Perrin (France); "Acceptance Testing of Equipment by Sampling," by Dr. Edilio Pautrie and Dr. A. Smid (Italy); "The Application of Statistical Methods to the Acceptance and Testing of Small Equipment," by the Giunta Tecnica Edison Group (Italy); "The Influence of Washing Machines on the Network Load," by W. Pfahler and Ch. Morel (Switzerland); "Definition of Terms Used in Electricity Statistics, General Report of the Working Group on Nomenclature."

**Protection of Telecommunications Study Committee.** Chairman: G. Jancke (Sweden). "Co-operation between the International Union of Producers and Distributors of Electrical Energy with the International Consultative Committee for Telephones," by Maurice Paimboeuf (France).

# T.U.C. at Southport

## *President's Arbitration Suggestions*

NEARLY 1,000 delegates have attended the 87th Trades Union Congress at Southport this week. This year's president, Mr. C. J. Geddes, general secretary of the Union of Post Office Workers, spoke in his address last Monday of the serious economic situation that could develop in a period of full employment.

He said that the workers could not lightly evade their responsibilities. If the situation took a drastic change for the worse, it was the trade union members who would be the first to suffer.

It was suggested that prices were rising too quickly and production not fast enough; that we were spending too much and saving too little; that we were importing more than we could pay for by our exports; that the stability of the Pound was threatened and that our export markets were being endangered by price and by rising competition. It was suggested that wage demands were threatening our economic structure and unless something were done and done quickly we were on the road to a deep depression with consequent unemployment and lowering standards of living.

Was this all just economic humbug designed to frighten the unions away from claiming and obtaining their just share of the results of a period of apparent and continuing prosperity? They could not just shrug aside these questions as though they had no significance, no importance for the movement. Some of these fears were more real than others, but even if they were exaggerated they must know how true or how false they were.

Industrial suicide was quite as momentous a decision as personal suicide. If they were pricing themselves out of the export market they were pricing themselves out of a job—and that was industrial suicide. If they were not prepared to listen to the advice of politicians or economists should they not at least find out the facts for themselves?

In a reference to strikes, Mr. Geddes said the Chancellor of the Exchequer had blamed strikes as one cause for the deterioration in the economic situation. They might resent this suggestion as an excuse for Government failure, but they could not deny the truth of the assertion that they might well have been a contributory factor. If they accepted the need for rising production, and they had no alternative, they must consider not only the cost of but the means of production. Any disturbance in the even flow from the production lines must be considered and a serious disturbance considered very seriously. They could not, and should not, try to abolish strikes, but they must remove as many causes for them as they could. Adequate arbitration machinery would appear to be the means by which most of the causes could be very greatly reduced.

Arbitration was so much a part of British industry that they had, as it were, created an industrial judiciary and given it powers which were greater than those of the legal judiciaries. Its decisions were final and there was no appeal. Was it not time we overhauled this vital part of the machine? If arbitration was to be truly effective trade unionists must prefer to use it rather than to take strike action. Why should not consideration be given to the setting up of an Arbitration Appeal Tribunal where both sides could seek a second opinion? There were obvious disadvantages but were they greater than the present ones which permitted decisions, often affecting millions of workers, to be made behind locked doors and against which there was no appeal but a strike?

Mr. Geddes said that the word "automation" merely gave a new twist of meaning to words which at one time frightened them but which were now commonplace—words such as "mechanization" and rationalization." To fear automation would be a cowardly approach; it could arise only from a sense of weakness.

# Storm Warning for Britannias

A NEW search radar that can see dangerous storm clouds from a distance of 120 miles will be fitted to the B.O.A.C. fleet of Bristol Britannias. They will be the first British airliners capable of "seeing" their own way through the cumulo-nimbus storm clouds that gather on air routes through the tropics.

Turbulence in cumulo-nimbus clouds has been long recognized as a danger to aircraft flying in tropical areas, and with the greater speeds of modern aircraft the need for adequate warning of turbulent conditions is becoming even more necessary.

This new radar equipment, made by Ekco Electronics, Ltd., provides storm warning at up to 120 miles range and can be used for map-painting and avoiding high ground. It operates on a wavelength of 3 cm, and provides good angular resolution and maximum clear air range.

Simplicity of operation is important and for this reason an "iso echo contour" display has been incorporated. This new circuit gives a clear indication of the position of severe turbulence. In addition, a special "high brightness" cathode-ray tube is used so that the display may be seen in ordinary cockpit conditions without the use of a visor.

# VIEWS on the NEWS

*By REFLECTOR*

IT is satisfactory to be reminded that although the English Electric Co. has just lost an American order for generators and transformers it was successful on an earlier occasion. Ten transformers for the Chief Joseph Dam power station are now being shipped by the company. The first arrived in May when it became front-page news for a local paper, the *Wenatchee Daily World* ("Published in the apple capital of the world and the buckle of the power belt of the great Northwest."). This paper announced that the amount paid for the transformers has been more than offset by purchases of Washington and Oregon apples by Great Britain in 1954 and 1955—most of the fruit coming from the Wenatchee Valley. Although "English Electric and Its People" heads its report "U.S. Apples Paid for Our Transformers," I am credibly informed that this was not a barter transaction.

* * *

Recent reports on the "Videophone," which enables parties to a telephone conversation to see one another, prompt a correspondent to the *Manchester Guardian* to complain of the antiquated form of the modern telephone. He refers to the "physical performance of lifting a plastic contraption from a rest, holding one end to an ear and speaking into an orifice at the other, unchanged since the inception of telephoning." There have, of course, been improvements in transmitter-receivers since then and it is possible to obtain instruments which do away with the handset (but not from the G.P.O.). The Post Office nowadays can avoid making any fundamental changes by pleading that first of all they must catch up on arrears. One day, perhaps, the *Manchester Guardian* correspondent will no longer have to "spend hours daily with one hand immobilized and one ear allocated to the use of this farcically antiquated gadgetry."

* * *

Courtesy costs nothing, but often has a good effect. Evidently the South Western Electricity Board is thinking on those lines. Several roads are up in Plymouth just now for cable laying, and the gangs of workmen have erected in front of them a large notice board bearing these words:—"Sorry to trouble you, but Plymouth needs more power."

* * *

Charges against a man of stealing gas and fraudulently abstracting electricity (a fine distinction!) were dismissed by the Abercynon (Glamorgan) magistrates recently. It appeared that the defendant had inserted filed halfpennies and steel discs into his prepayment meters. Evidence showed that this was common practice; the amount due would be made up when the meters were emptied. No doubt the frequent shortage of shillings in some parts of the country has made it necessary. In view of this the presiding magistrate decided that there could be a conviction only if fraudulent intent was proved and this the prosecution had failed to do. If the consumer in any such case is prepared to pay up it is difficult to see how fraudulent intent could ever be proved. Although no doubt the practice is quite irregular (and maybe unlawful) the gas and electricity authorities do not suffer—unless their meters are damaged. I doubt whether Electricity Boards approve the system, however. More shillings would solve the problem.

* * *

The August issue of the *Farmer's Journal*, the official organ of the Ulster Farmers' Union, describes hydro-electric schemes as "antiquated." It says:—

> "Surely in the modern times we are passing through the present hydro-electric schemes are antiquated and completely out of date, sufficing only to use up good agricultural land. They are, in our opinion, only a waste of time when we have around the corner the vast field of nuclear energy."

This is one more instance of the popular misconception of the part which nuclear power will play in the near future in the generation of electric power. For a long time to come atomic power can only be complementary to existing resources, and we shall have to go a good deal further than "round the corner" before we can dispense with thermal and hydro-electric generation.

* * *

Appealing for funds for the preservation of the Union Windmill, Cranbrook, Kent, which was built in 1814, "Abner" in the *Architect and Building News*, says:—"The windmill can still work, although an electric motor is normally used." I don't like this ambiguous use of the word "although" by my fellow "columnist."

* * *

Misgivings about our prodigal use of coal were expressed seventy years ago by Sir Lyon Playfair, president of the British Association for the Advancement of Science, at the Association's Aberdeen meeting. As reported in the *Electrical Review* of 12th September, 1885, he said:—

> "The coal which has hitherto been the chief source of power probably represents the product of five or six million years . . . . But we are using this conserved force wastefully and prodigally; for although horsepower in steam engines has so largely increased since 1864 two men only now produce what three men did at that date . . . . According to Professor Dewar, in less than two hundred years more the coal of this country will be wholly exhausted, and in half that time will be difficult to procure. Our not very distant descendants will have to face the problem—What will be the condition of England without coal? The answer to that depends upon the intellectual development of the nation at that time . . . . It may be that when the dreaded time of exhausted fuel has arrived its importation from other coal-fields, such as those of New South Wales, will be so easy and cheap that the increased technical education of our operatives may largely overbalance the disadvantages of increased cost in fuel. But this supposes that future Governments in England will have more enlightened views as to the value of science than past Governments have possessed."

# Good Installation Practice

*Provisions of Part 2 of the New Edition of the I.E.E. Wiring Regulations*

PARTICULARS of the new (thirteenth) edition of the I.E.E. Regulations for the Electrical Equipment of Buildings were given in the *Electrical Review* of 2nd September, with a summary of Part 1, which set out the basic requirements of safety.

Part 2 concerns good practice which would enable these requirements to be met. It differs mainly from the previous edition of 1950 in a rearrangement of the Sections and the rewriting of the text in simpler form and in incorporating recent developments, more especially in regard to cable ratings. The total sum of the regulations, apart from those relating to private plants, now relegated to an appendix, has been reduced from 158 to 132 and their numbering is entirely different.

The opening section is now termed " Control, Distribution and Excess-Current Protection " and incorporates the main features of the old independent section dealing with final sub-circuits and diversity. The two sections on conductors and cables have been fused together as have the two on installing accessories and current-using apparatus and the further two on electric discharge lamps. The remaining sections (bringing the total to eight instead of thirteen) which deal with earthing, testing and inspection, design and construction and temporary installations remain as before with some modifications. There are 38 tables (including six in the main body of the text) of which 16 relate to cable ratings.

New features in appendices are a list of electrical Codes of Practice and a typical form of Ministerial approval of protective multiple earthing. Another appendix sets out rating factors for special dispositions of single, twin or multicore cables run in closed trenches or in proximity to iron; this replaces the appendix on correction factors for current ratings of single-core cables in the previous edition.

## Definitions

In the expanded definitions, " cable, polythene-insulated " makes its first appearance; so does " intrinsically safe," denoting inability of sparking in normal working to cause an explosion of any prescribed inflammable gas or vapour. " Switchfuse " is now used instead of " switch-and-fuse " to distinguish a switch with a fuse not carried on its moving part from a fuse-switch in which it is. The term " earth-free situation " has now been dropped.

Maximum ambient temperatures in which ordinary cables may be installed have been increased from 66 to 75 deg C for impregnated paper and varnished cambric, but are substantially the same for rubber and p.v.c. An addition is asbestos-roved rubber and asbestos-roved cambric, for which 80 deg C is permissible for cables and 85 deg C for conductors of flexible cords. The use of varnished cambric insulated cables not metal sheathed is permissible only for short lengths not exposed to moisture. Where rubber, p.v.c. or polythene insulated cables are connected to busbars reaching 90 deg C the insulation must be removed for 6in.

Among other departures from 1954 requirements are that cables installed in inflammable or explosive-dust situations shall be enclosed in screened solid-drawn steel conduit or be metal-sheathed and armoured or mineral-insulated metal-sheathed. Aluminium-sheathed cables in underground pipes or concrete ducts need a corrosion-resistant finish, for which bitumen or bituminized paint may not be sufficient. Other precautions relating to aluminium- and zinc-base alloy conduits and fittings, in view of their generally inferior mechanical strength, are mentioned in notes.

A new clause gives a choice of five consumers' distribution systems between buildings, as follows: metal-sheathed and served cables, if necessary armoured or in pipes, or alternatively mineral-insulated copper-sheathed cables, if necessary with bituminized felt wrapping, laid in each case at least 18in deep; conduit containing rubber-insulated and braided cable, or rubber- or p.v.c.-sheathed cable, gaps between buildings being spanned by one unjointed length of steel conduit overhead; cleated t.r.s. cable with partly embedded braid and overall compound, or standard house-service overhead-system cable, or polychloroprene-sheathed cable or p.v.c.-insulated and p.v.c.-sheathed cable —all suitable for gaps up to 10 ft. The remaining two systems employ cables similar to those in the last-mentioned case, but these are supported either by a catenary incorporated in or separate from the cable or on insulators.

Under the heading of current-using apparatus a definite minimum distance of 12in is stated for a lighting fitting below a sprinkler head (if unavoidable). The capacity of oil-filled apparatus above which means of drainage and prevention of escape of oil to other parts of a building must be provided has been lowered from 50 to 20 gal.

The note deprecating the use of lampholder plugs has been strengthened by the addition of the words " in any circumstances " and by a reference to the special danger of using bayonet-cap lampholder plugs to supply Edison-screw or centre-contact bayonet lampholders. Reversible connectors should not be used to supply apparatus incorporating a single-pole switch or thermostat unless parts remaining alive when the switch is off are so shrouded that they cannot be touched.

The prohibition of the use of an auto-transformer to supply a portable appliance has been relaxed in respect of one contained in the appliance. Capacitors, other than small units which cause no risk of shock or those for radio-interference suppression, must have means (e.g., a high-resistance leak) for prompt automatic discharge on disconnection of supply.

A new regulation, covering mains-operated electric fence controllers, prohibits their being fixed to any pole of a power or telecommunication overhead line, except where they are supplied at low voltage by insulated line from a distribution board. Their earth electrodes must be separate from and situated outside the resistance area of any electrodes used for protective earthing. There are also other requirements to be observed.

## Earthing Requirements

In the section entitled " Earthing " the basic requirement, as now stated, is that a fault of negligible impedance from a phase or non-earthed conductor to adjacent exposed metal, should result in a current flow corresponding to three times the fuse rating or 1½ times the setting of the overload circuit-breaker, thus making the faulty circuit dead. Where this requirement cannot be met an earth-leakage circuit-breaker is required, either voltage-operated or of the current-balance type or a combination of the two.

The former is connected by an insulated conductor between consumer's earth terminal and an earth electrode placed outside the area of any parallel earth connection. This alternative should operate when the earth leakage current attains not more than 15 per cent of the rated current for the circuit or 5 A, whichever is the greater. Another

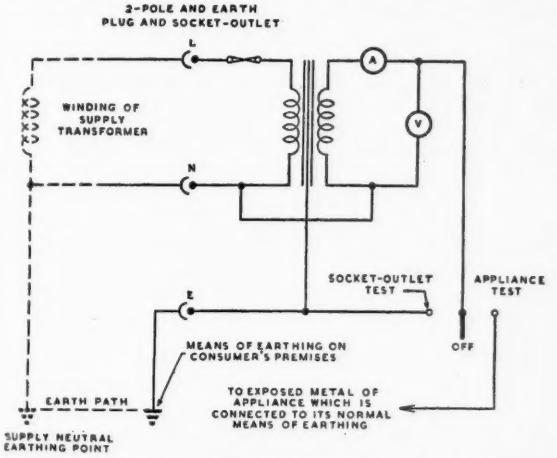



*Diagram showing a method of loop testing using simple test equipment*

modification provides that the area of an earth-continuity conductor contained in a cable, flexible cable, or flexible cord shall be equal to that of the current-carrying conductors. Attention is drawn to the need to subdivide the earthing system where earth-leakage circuit-breakers are used and the desirability of providing noise-free conditions for radio or television receivers; resistance areas of electrodes must not overlap. In bathrooms the use of totally enclosed lighting fittings is recommended.

The testing of an installation is desirably carried out in the sequence of: verification of polarity; insulation tests; earthing tests. In any preliminary test on the wiring before lamps are installed the insulation resistance to earth should be not less than 100 megohms (25 megohms for p.v.c.-insulated cable) divided by the number of outlets. Half these values may be taken for a test between phase and neutral; this does not apply to earthed concentric wiring.

Where fuses or overload circuit-breakers are employed for protection against dangerous earth-leakage currents, each completed installation and, if possible, each final sub-circuit must be tested by means of an earth-fault loop impedance tester of the current-injection type. The test current should be preferably approach $1\frac{1}{2}$ times the rating of the sub-circuit, but need not exceed 25 A. The V/I ratio may be taken as the total earth-fault loop impedance. A method of testing with simple equipment is shown in the accompanying diagram. The same current conditions apply to a separate test at supply frequency of an earth-continuity conductor of an a.c. installation under conditions specified.

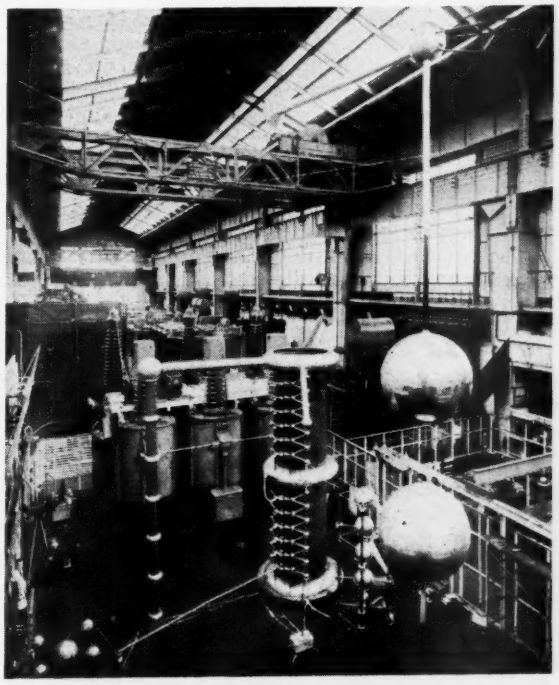
A general note to the section on design and construction recommends giving consideration to providing additional protection (e.g., a thermal cut-out) for apparatus, such as a radio receiver or refrigerator, which may run unattended for long periods, since a small overload insufficient to blow the sub-circuit fuse may introduce a risk of fire. The desirability of suppressing radio interference at source is referred to in a recommendation that capacitors should be fitted to the appliance itself. An exemption to the regulation regarding the isolation of high-voltage discharge lamps from supply mains, which is applicable in the case of a.c. two-wire circuits with one pole earthed, has been modified. The use of auto-transformers delivering a maximum voltage of 1,500 V measured on open circuit is now permissible as against the 1,000 V previously stipulated.

## Very-High-Voltage Impulse Testing

Impulse type tests have been successfully carried out on a complete 120 MVA, three-phase, 275/132 kV auto-transformer at the Heaton works of C. A. Parsons & Co., Ltd. This unit is one of seven 275 kV transformers at present under construction for the Central Electricity Authority. The type tests included, in addition to calibrating shots, three full waves at 1,050 kV and two chopped waves at 1,210 kV, applied to the 275 kV bushing on two phases, whilst on two phases of the 132 kV side three full waves at 550 kV and two chopped waves at 635 kV were applied.

Referring to the accompanying illustration of the testing installation, in the immediate foreground the 150 cm sphere gap can be seen together with the impulse generator and its associated potential divider. The impulse generator has a rated voltage of 2·5 million V in 12 steps and has an output of 60 kW-sec. The generator is specially designed to achieve a high voltage efficiency, that is, it possesses good regulation characteristics and is capable of producing a standard impulse wave form of 1/50 micro-second—within specified tolerances—on very large e.h.v. transformers.

This new testing plant, designed and constructed by the Electrical Research Division of C. A. Parsons, was commissioned in June, 1954. In the construction adopted for the impulse generator, all the separate stage condensers are oil immersed and are housed in two bakelized paper tanks which form the main structure of the generator embodying the trigger gaps, the inter-stage and other resistors. One electrode of the rod gap is incorporated in the generator and can be remote controlled. The generator, when not in use, can be lifted as a unit outside the test area in a separate steel container which also affords protection during storage.



*The C. A. Parsons very-high-voltage impulse testing installation showing 150 cm sphere gap and impulse generator in the foreground*

# Copper Semi-Manufactures *Monopolies Commission's Report*

THE report has been published of the Monopolies and Restrictive Practices Commission on the "Supply and Export of Certain Semi-Manufactures of Copper and Copper-based Alloys" (H.M. Stationery Office, 7s 6d).

In the terms of reference the following products were specified:—Brass strip, sheets and circles, wire, tubes, beadings and mouldings, rods and extruded sections; phosphor-bronze wire, strip and sheet; copper strip, sheets and circles, wire, tubes, sheathing, rods and extruded sections, tapes, bindings and jointing sleeves; nickel silver strip, sheets and circles, and wire; yellow metal sheets and circles, sheathing and condenser plates; and zinc strip.

Mentioning that most of the trade in these wrought products is direct with the user or further fabricator, the Commission says that the main feature of the market for the electrical products is that a relatively small number of buyers account for a large proportion of the sales. Dealing with the makers of wrought products it is stated that the Metals Division of Imperial Chemical Industries, Ltd., is the largest single producer and makes practically every product specified in the terms of reference. The next biggest unit is British Insulated Callender's Cables, Ltd., with which are associated another large producer, Thomas Bolton & Sons, Ltd., and several smaller concerns.

The next largest producers by weight of output are, in order, the Delta Metal Co., Ltd., which specializes in extrusion and has several subsidiaries in the industry, McKechnie Bros., Ltd., who also specialize in extrusion, Enfield Rolling Mills, Ltd., which makes most rolled products and also black hot-rolled copper rod, and the London Electric Wire Co. & Smiths, Ltd., which specializes in rod and wire. There is no concern or group of associated concerns whose output amounts to more than one-third of the total production.

Apart from these large groups it is usual for makers to concentrate either on high-conductivity copper goods for electrical purposes, which represent about one-third of the total output of the industry, or on copper and copper-alloy goods for general engineering or constructional purposes. A second class consists of about twelve concerns which make h.c. copper goods only. Many of them also make electrical equipment, e.g., cables, incorporating the h.c. copper wire, strip, etc., they produce. There are third and fourth categories producing non-electrical copper goods.

The report is somewhat "dated" by its reference to the course of the price of copper in the past few years when it says that since August, 1953, it has reached "as much as £310 a ton."

Particulars are given of the twelve associations in the industry and their scope indicated; the most important member of the group dealing with h.c. copper rods is the High Conductivity Copper Association which is concerned with most of the rod, wire, etc., sold for electrical purposes.

The scope of the activities of the British Non-Ferrous Metals Federation, to which ten of the twelve associations mentioned belong, is surveyed and attention is given to the regulation of trading practices by the Federation and the associations as well as to their research, development, standardization and educational activities. Many other aspects of the subject, including international co-operation, are dealt with at some length.

One of the tables included in an appendix shows that in 1953, for each group of products, the members of the relevant associations accounted for not less than 40 per cent by weight of the total production, in the United Kingdom, of that group of products, and that in most groups the proportion was much higher. In the aggregate for all groups the proportion was 76 per cent. United Kingdom production in 1953 was 472,764 tons.

In its conclusions the Commission balances the pros and cons of price regulation and considers that the average level of profits in the industry has been "comfortable, but not unreasonable," although the profits made by some manufacturers and in some sections have been high. The average level of costs and the general level of prices are higher than if there were free price competition. The Commission does not accept the argument that any advantages to the public from lower prices would be offset, or more than offset, by the damage which would be caused to the copper "semis" industry itself.

## Commission's Recommendations

It is recommended that all minimum price arrangements in the home market should be abrogated and that each manufacturer should be free to determine the price at which he will sell, to suit the circumstances of his own business. Other practices which should be ended include collaborating on tenders, fixing common terms for the purchase of scrap from customers, regulating re-sale prices, regulating the commission to members' agents, limiting the acceptance of bulk contracts, discriminatory prices to groups of customers, the prohibition on the supply of certain specifications, and the granting of "loyalty" and aggregated quantity rebates and discounts.

The Commission considers that, in so far as they operate to protect United Kingdom manufacturers from competition from imports in the home market, the arrangements with overseas manufacturers are against the public interest. As regards the effect of the industry's international arrangements on the country's export trade in copper "semis," the Commission is not satisfied that, considered solely from the point of view of exports, they are necessarily against the public interest. On balance, the Commission is not prepared to say that at present the agreements on minimum export prices necessarily operate against the public interest, but it thinks that if they are not abandoned as a result of the abolition of minimum prices in the home market, their effect should be further reviewed in two or three years' time in the circumstances then prevailing.

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Upon the publication of the report a statement was made by the British Non-Ferrous Metals Federation disagreeing with the Commission's findings which the Federation contended were in line with the sweeping recommendations in its general report on restrictive business practices which the Government did not accept.

The Commission recognized that home prices were lower than those in most European countries and North America. As the products dealt with were semi-finished the producers did not deal with the public but with powerful manufacturing and trading concerns or with powerful overseas mining groups or their agents who supplied their raw materials.

The industry had no private courts, stop-lists, collective boycotts, no retail price maintenance or quotas. In general there was no criticism by customers of the price agreements or price levels. There was no real monopoly in the industry; effective and substantial competition came from outside companies.

Only by co-operation in pricing had the industry been able to carry on the research and development which the Commission had fairly recognized.

# PERSONAL AND SOCIAL

## *News of Men and Women of the Industry*

**Mr. G. P. Belsham** has been appointed sole managing director of Brookhirst Switchgear, Ltd., and **Mr. D. W. Kent** to a similar position with the Igranic Electric Co., Ltd. On taking up this appointment Mr. Kent will relinquish his seat on the board of Sentinel (Shrewsbury), Ltd. **Mr. E. Bruce Ball,** O.B.E., has joined the boards of Sentinel (Shrewsbury), Ltd., Fawcett, Preston & Co., Ltd., Finney Presses, Ltd., and Ferrous Castings, Ltd. All of the companies mentioned are members of the Metal Industries group.

**Mr. C. E. H. Verity,** O.B.E., M.I.C.E., M.I.E.E., M.I.Mech.E., deputy chief engineer (power station construction) of the Central Electricity Authority, is relinquishing that position on 30th November to take up an appointment on the board of Foster Wheeler, Ltd.

*Mr. C. E. H. Verity*

Mr. Verity was born at Chard, Somerset, in 1901 and was educated at Wellingborough School and Bedford Technical College. After technical training with W. H. Allen, Sons & Co., Ltd., he became contracts engineer to that company. He was appointed technical engineer to the Contraflo Engineering Co. in 1924 and three years later joined the London Power Co. as technical engineer, becoming head of the technical department (mechanical engineering) in 1932. After serving in the R.A.F. from 1941 to 1945 he returned to the London Power Co. as chief development and testing engineer, a position which he held until the nationalization of electricity supply. In 1948 he was appointed generation construction engineer by the British Electricity Authority and he became deputy chief engineer in 1950.

**Dr. A. H. M. Arnold,** principal scientific officer at the National Physical Laboratory and head of the Electronics Section of the Electricity Division, has been appointed Reader in Electrical Engineering at King's College, London University.

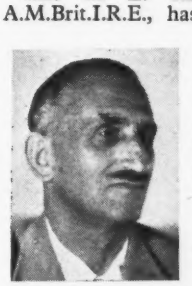
The Simplex Electric Co., Ltd., announces the following appointments consequent upon a reorganization of the Creda sales staff covering, in the main, the London, Eastern and South Eastern areas:—**Mr. B. J. Hendy** has been appointed Creda heating and cooking sales engineer, London, with special duties concerned with Government Departments, etc. **Mr. J. S. Gurnett** becomes Creda area sales engineer, Eastern, London and Southern areas, and is succeeded as sales engineer, Eastern area, by **Mr. K. J. Vicars. Mr. A. D. Whitaker** is appointed water heating sales engineer in the Midlands, South Wales and South Western areas; and **Mr. M. A. L. Wingate** Creda sales engineer covering the Croydon and Kent area. **Mr. H. E. Wilson's** responsibilities for the South Eastern area remain unchanged.

**Mr. W. H. Grinsted,** O.B.E., has been appointed technical director of Siemens Brothers & Co., Ltd.

**Mr. C. T. Porter,** superintendent of Darlington power station since 1941, is to retire. He entered the service of Darlington Corporation Electricity Department at Darlington power station when he was seventeen and has remained there ever since.

**Sir Summers Hunter,** who recently retired as managing director of Richardsons Westgarth & Co., Ltd., and its subsidiary companies, has joined the board of Vent-Axia, Ltd.

**Mr. H. L. Ranson,** M.S.M.A., A.M.Brit.I.R.E., has been appointed to the position of general sales manager of Besson & Robinson, Ltd. (part of the Electronics Division of the Gas Purification & Chemical Co., Ltd.). Mr. Ranson was until recently general sales manager of the Furzehill Group.



*Mr. H. L. Ranson*

Owing to pressure of his other business activities **Mr. C. I. Steen** has resigned from the position of chairman of Hackbridge Cable Holdings, Ltd. To fill the vacancy **Sir W. Wavell Wakefield** has been appointed to the board and elected chairman. In his statement to be presented at the company's annual meeting on 23rd September the new chairman also refers to the retirement of **Mr. C. W. Bloomfield,** the managing director, who founded the original business in 1912 and was the first chairman of the company. **Mr. W. L. Brown,** a director of several of the company's trading subsidiaries, has been nominated to fill the vacancy on the board of the holding company. **Mr. A. L. Foulger** has been appointed deputy managing director and is succeeded as secretary by **Mr. F. G. Newton.**

**Dr. Thomas Girtin** has retired from the chairmanship of Johnson & Sons Smelting Works, Ltd. He joined the board of the parent company, Johnson, Matthey & Co., Ltd., in 1921 from Raphael's Refinery, where he had been general manager, and remained on that board until 1952. His appointment as chairman of Johnson & Sons Smelting Works came in 1930 after he had been actively concerned in the amalgamation of the two companies. Among his early work for Johnson, Matthey & Co. were the reorganization and integration of the refineries at Hatton Garden. Later he was responsible for building the Research Laboratories at Wembley and for their organization. He also prepared the plans for rebuilding the head offices at Hatton Garden and supervised this work until the war caused it to be suspended. In 1953 the honorary degree of D.Litt. was conferred upon him by Leeds University for his notable services to education, particularly in the field of fine arts, and for his services to industrial science.

*Dr. T. Girtin*

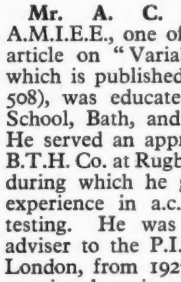
**Rear-Admiral Sir Philip Clarke,** K.B.E., C.B., D.S.O., has been nominated for re-election as president of the British Institution of Radio Engineers for the year 1955-56. **Mr. G. A. Marriott,** B.A.(Cantab.), **Mr. L. H. Paddle, Mr. J. L. Thompson** and **Professor E. E. Zepler,** Ph.D., have been nominated for re-election as vice-presidents. Nominations for ordinary members of Council are: Members—**Air Vice-Marshal C. P. Brown,** C.B., C.B.E., D.F.C., **Mr. J. W. Ridgeway,** O.B.E., and **Professor E. Williams,** Ph.D., B.Eng. Associate Member—**Mr. R. N. Lord,** M.A.(Oxon). Companion—**Mr. A. H. Whiteley,** M.B.E. The election of officers will take place at the annual general meeting on 26th October.

**Mr. R. Burges** has been appointed publicity manager of Birlec, Ltd., in succession to **Mr. J. C. Mantell,** M.B.E., as from 19th September. Mr.

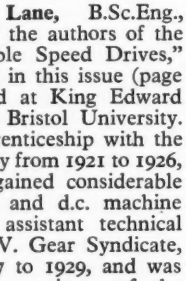
Burges, who read physics at St. Peter's Hall, Oxford, joins the company from Langley Alloys, Ltd., Slough. Mr. Mantell remains within the A.E.I. group, in which he will take a two years' training course with the British Thomson-Houston Co., Ltd., Rugby.

**Mr. H. V. Potter,** B.Sc.(Hons.), F.R.I.C., M.I.Chem.E., F.P.I., chairman and managing director of Bakelite, Ltd., has asked the board to be relieved of the position of managing director and this will take effect as from 31st October. He will continue as chairman. At the same time **Mr. F. J. Robinson** will vacate the position of deputy managing director and the board has appointed **Mr. G. W. Hodds** as managing director as from 1st November. Mr. Potter has been with the company since 1914. He became works manager in 1918, general manager in 1921, managing director in 1926 and chairman in 1948.

**Mr. A. C. Lane,** B.Sc.Eng., A.M.I.E.E., one of the authors of the article on "Variable Speed Drives," which is published in this issue (page 508), was educated at King Edward School, Bath, and Bristol University. He served an apprenticeship with the B.T.H. Co. at Rugby from 1921 to 1926, during which he gained considerable experience in a.c. and d.c. machine testing. He was assistant technical adviser to the P.I.V. Gear Syndicate, London, from 1927 to 1929, and was appointed assistant engineer of the Motor Engineering Department, B.T.H., Rugby, in charge of a.c. commutator motor design in 1929. He still holds this position and is concerned particularly with Schrage motor developments, both as regards design and manufacture and also with their application to industry.



*Mr. A. C. Lane*



*Mr. B. H. Stockman*

**Mr. B. H. Stockman,** B.Sc., the joint author, received his technical education at Rugby College of Technology and Arts. He served an engineering apprenticeship witht the B.T.H. Co., Rugby, from 1928 to 1933 and then became assistant engineer in the company's Motor Engineering Department. He has been engaged in d.c. machine design from 1934 to date and he has had a wide experience in designing d.c. machines to meet the special requirements of most types of drive, with many opportunities of gaining first-hand experience of actual operating conditions.

**Mr. J. Webb,** M.Sc., who writes in this issue on "Relaxation Solution Involving Refraction," started his engineering training as a cadet at the College of Technology, Belfast, but his studies were interrupted in 1944 when he was commissioned in the Air (Engineering) Branch of the Royal Naval Volunteer Reserve. In 1946 he went to the Queen's University of Belfast and graduated as B.Sc. in 1948, and in 1954 he obtained his M.Sc. degree. Mr. Webb is now teaching electrical engineering subjects in the College of Technology, Belfast, but is also engaged in part-time research work on relaxation methods.

*Mr. J. Webb*

The annual ball of the **Electrical Trades' Commercial Travellers' Association** is being held at the Park Lane Hotel, Piccadilly, London, W.1, on 7th October, from 7 p.m. to 2 a.m. (reception 7 for 7.30 p.m.). Tickets, 37s 6d each, are obtainable from the hon. social secretary, Mr. A. J. Murray, c/o British Electric Lamps, Ltd., 229, Westminster Bridge Road, S.E.1. Applications should be made before 26th September.

The **West Lancs, Merseyside and North Wales E.I.B.A. Area Golf Competition** took place at Heswall on 30th August, when 58 competitors played for the Britton Bowl. The major competition was won by G. Baker (18), with a net score of 61, and the runner-up was F. Warren (13) with a net score of 63. The best scratch score was returned by H. Harding (3) with 76 after a tie with H. Dodd (6) and F. Warren (13). A greensome competition was held in the afternoon, the prize-winners being F. Warren and R. Rawle (13½) with 63½ net, and the runners-up were R. Gravett and G. Elston (21½), with 66½ net. As a result of this event £425 is being sent to the E.I.B.A. Golf Committee.

## OBITUARY

**Mr. H. Hillier.**—The death occurred on 27th August of Mr. Harold Hillier, O.B.E., M.I.Mech.E., M.I.Mar.E., engineering and technical director of G. & J. Weir, Ltd. Mr. Hillier, who was sixty-four years of age, was in control of all design work and technical development of the firm. He served his apprenticeship with Vickers-Armstrongs, Ltd., and joined G. & J. Weir, Ltd., in 1930, when they acquired the business of the Contraflo Engineering Co., Ltd., whose specialities he had played a leading part in developing. In 1933 he was appointed to the board of Weir's. During the war Mr. Hillier was a consultant to the Admiralty, and also served on various committees dealing with weapon design. He was an active member of several learned societies.

The funeral took place at Woodside Crematorium, Paisley, on 30th August. Among those who attended were Viscount Weir of Eastwood, the Hon. J. K. Weir, Mr. James G. Weir, other directors of G. & J. Weir, Ltd., and associated companies, and representatives of all departments of Holm Foundry.

**Mr. C. A. Vandervell.**—A pioneer of automobile electrical equipment, Mr. Charles Anthony Vandervell, died on 30th August at the age of eighty-four. Earlier in this century Mr. Vandervell devised battery charging and battery ignition systems which constituted a great advance in car equipment. His business was made a public company in 1916 and was later taken over by the Joseph Lucas group.

## British Radar for Venezuela

Venezuela is to equip four of her most important civil and military airfields—Maiquetia, Puerto Cabello, Maracaibo and Barcelona—with radar equipment manufactured by Decca Radar, Ltd. The equipment comprises Type 424 airfield control radar developed by Decca Radar to assist the approach to landing of aircraft during adverse weather conditions, and Type 41 storm warning radar for use in the preparation of aviation weather forecasts. Technicians from the Decca Radar organization are expected to arrive in Venezuela to commence supervision of installation work at the end of October.

## PRICES OF MATERIALS

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

| | |
|---|---|
| ALUMINIUM Ingots | ton £171 0s 0d |
| COPPER, H.C. Electro | ton £394 10s 0d |
| Fire Refined 99·70% | ton £393 0s 0d |
| Fire Refined 99·50% | ton £392 0s 0d |
| COPPER Tubes .. | lb 3s 9½d |
| Sheet .. .. .. | ton £460 10s 0d |
| H.C. wire and strip .. | ton £438 15s 0d |
| LEAD, English .. | ton £107 2s 6d |
| Foreign .. .. | ton £106 0s 0d |
| MERCURY .. .. | flask £95 0s 0d |
| TIN, block (English) .. | ton £744 15s 0d |
| ZINC, G.O.B. Foreign | ton £90 15s 0d |
| Electrolytic .. .. | ton — |
| BRASS Tubes (solid drawn) .. .. .. | lb 2s 11⅜d |
| Sheet .. .. .. | ton £355 10s 0d |
| Wire .. .. .. | lb 3s 6⅜d |
| PHOSPHOR BRONZE Wire .. .. .. | lb 5s 3½d |
| PLATINUM .. .. | oz £29 0s 0d |
| RUBBER, No. 1 R.S.S. spot .. .. .. | lb 43¼d—43½d |

Under its fixed price scheme for copper the Rhodesian Selection Trust has raised its price from £325 to £360 per ton c.i.f. United Kingdom. The price is subject to revision at 24 hours' notice.

# INDUSTRIAL NEWS

## Employment in the Electrical Industry

According to a survey published in the August Ministry of Labour Gazette, the estimated working population of Great Britain at the end of June was 23·9 million; of this number 22·9 million were in civil employment, representing an increase of 290,000 compared with June, 1954. An industrial analysis shows that there were increases in all sections of the electrical industry for which figures are given, with the exception of battery and accumulator manufacture in which there was a small reduction.

| Industry | Men | | Women | | Total | |
|---|---|---|---|---|---|---|
| | End of June | | End of June | | End of June | |
| | 1954 | 1955 | 1954 | 1955 | 1954 | 1955 |
| Electrical machinery ... ... ... | 132,100 | 137,600 | 44,100 | 49,400 | 176,200 | 187,000 |
| Electrical wires and cables ... ... | 38,200 | 41,200 | 20,500 | 23,000 | 58,700 | 64,200 |
| Telegraph and telephone apparatus... | 31,500 | 33,300 | 20,300 | 23,000 | 51,800 | 56,300 |
| Radio apparatus and gramophones ... | 64,000 | 72,300 | 54,600 | 68,200 | 118,600 | 140,500 |
| Radio valves and electric lamps ... | 21,600 | 24,600 | 23,700 | 28,200 | 45,300 | 52,800 |
| Batteries and accumulators ... ... | 11,300 | 11,300 | 9,300 | 8,700 | 20,600 | 20,000 |
| Other electrical goods ... ... | 94,300 | 101,20 | 65,800 | 73,400 | 160,100 | 174,600 |
| Electric wiring and contracting ... | 65,100 | 67,500 | 7,900 | 8,700 | 73,000 | 76,200 |
| Electricity supply ... ... ... | 171,200 | 176,200 | 22,800 | 23,800 | 194,000 | 200,000 |
| Totals ... ... ... ... | 629,300 | 665,200 | 269,000 | 306,400 | 898,300 | 971,600 |

Unemployment generally was the lowest recorded since the war. For the electrical industry the figures at 11th July were as follows, with 1954 comparisons in parentheses:—Electrical machinery, 528 (677); wires and cables, 272 (380); telegraph and telephone apparatus, 278 (361); radio apparatus and gramophones, 711 (719); radio valves and electric lamps, 234 (295); batteries and accumulators, 150 (186); other electrical goods, 789 (942); electric wiring and contracting, 552 (905); and electricity supply, 542 (703).

## New A.E.I. Group Factories

What is claimed will be the largest steam turbine factory in Europe is being erected by the British Thomson-Houston Co., Ltd., at Larne, Northern Ireland. The foundation stone of the office block is to be laid by Lord Brookeborough, Prime Minister of Northern Ireland, on 29th September. It is expected that the factory will be completed in two years' time and 3,000 people will be employed there.

The production of cathode-ray tubes at a new works built by the Edison Swan Electric Co., Ltd., at Pallion, Northumberland, is to begin in about five weeks' time.

## Science and Management

The British Institute of Management has published the advance programme of its national conference to be held this year at Harrogate from 2nd to 4th November. The conference will have as its theme "The Impact of Science on Management in the Future." Stress will be laid throughout the conference on the need to translate new scientific discoveries into immediate and practical day-to-day effect. "Automation" is only one of the new techniques which will form the subject of sectional meetings. Others include the uses of radioactive isotopes and the electronic processing of data, while a panel representing scientists in industry will discuss changes brought about by recently developed materials and processes. The application of scientific techniques to retailing and market analysis will be studied. Special attention will be paid to the human aspects of technological progress and to the problems of training managers to meet the needs of the future.

## Liverpool Productivity Exhibition

In connection with the Productivity Exhibition held at Liverpool from 25th August to 3rd September, a report of which appeared in last week's issue, the Merseyside and North Wales Electricity Board entertained some sixty prominent industrialists in the area to a luncheon on 26th August, when the guest speaker was Mr. L. Landon Goodman, industrial engineer of the British Electrical Development Association. Mr. D. H. Kendon (chairman of the Board) presided, and others present included Mr. James Rankin (deputy chairman of the Board), Board members and senior officers, and Mr. A. R. Cooper (divisional controller).

Mr. Kendon said that in their area last year industry used about 18 per cent more electricity than in the previous year, and obtained it at a lower price. That was a measure of the contribution the electricity supply industry was making to productivity. It had substantially increased its own efficiency of production, and could help by being a channel between the makers of the latest production aids and those people who could put them to use.

Mr. Landon Goodman said it was often overlooked that the relative cost of a horse-power-hour of human energy was 480 times as much as a horse-power-hour of electrical energy. Every endeavour must be made to find ways of placing more and more electrical and electronic equipment at the worker's command.

During the last three years the horse-power per worker in the United States had just about doubled; it was now between 11 and 13½ and would shortly be up to 15. In this country the figure was now about 4. These figures were matters for grave reflection, even when the differences between United States and British industry were taken into account. High figures of horse-power per worker did not result from greater numbers of motors and electric furnaces alone. One small electric servo-mechanism taking itself but a few watts might be the means of allowing hundreds of horse-power to be placed under one worker's command.

He stressed that the electrical system in a factory should itself be extremely flexible, for methods and loads were continually changing. There was little difference in first

*The Merseyside and North Wales Board's stand at the Liverpool Productivity Exhibition*

*Part of the Atlas lighting installation at London Airport*

cost between a wiring system that was just large enough for one's needs and one that would take care of double the present needs. In the fields of materials processing electro-heat was unique, providing heat just where it was required, cleanly, accurately and controllably and allowing the fullest advantage to be made of plant flexibility. Mr. Goodman went on to mention the value of battery-electric industrial trucks for indoor operation, instrumentation and control and improved output—brought about by proper lighting.

## I.T.A. Transmissions from Croydon

The Independent Television Authority announces that it will begin regular high-power test transmissions from its Croydon transmitter on 13th September at 6 p.m. when the station will be formally opened by the Mayor of Croydon. The 1 kW transmitter which has been operated by Belling & Lee, Ltd., since last April will close down on 10th September.

The I.T.A. transmitters will operate as from 14th September from 9.30 a.m.-12.30 p.m., 2 p.m.-5.30 p.m. and 7.30 p.m.-8.30 p.m. on Mondays to Fridays and 10 a.m.-1 p.m. on Saturdays.

## Lighting at London Airport

A lighting scheme recently completed at London Airport includes 540 fluorescent and over a hundred incandescent fittings. In the air-side loading bay are eighty-three "troffer" units with 80 W fluorescent tubes and quick-start gear, which leave the ceiling free from obstruction and give continuous glare-free lighting.

The mechanical and engineering service room in the control building uses "Atlas TF/0080" fittings with quick-start control gear (Thorn Electrical Industries, Ltd.). These narrow-angle reflector fittings are arranged to throw light on to banks of electrical equipment. "Atlas FEQ" fittings have been installed in the trucking corridor, locker room, drying room, store room, bonded stores, crew room, Customs room and cabin service stores and a further group of these fittings with "Miracoat" finish are installed in the B.E.A. kitchens. The main transit lounge and the restaurant and lounge on the second floor use over 100 George Forrest "GD/6193" incandescent fittings which harmonize well with the modern design of these rooms.

In the approach control room the lighting is controlled by Atlas dimming equipment, making it possible for the operators to adjust the illumination level to enable the radar screens to be viewed under all conditions.

The architect was Mr. Frederick Gibberd, F.R.I.B.A., and the consulting engineers Messrs. Ewbank & Partners.

## Demonstration Caravan

The lightweight caravan shown in the accompanying photograph is used by the Kenwood Manufacturing Co., Ltd., to display and demonstrate its food mixers at agricultural shows. Drawn by a two-ton Ford diesel truck in which there is a sleeping compartment for the driver, the trailer is taken to shows in various parts of the country throughout the summer months. The caravan, made by Berkeley Coachwork, Ltd., is 22ft long and 7½ft wide. One side lets down for demonstration purposes. At one end of the trailer is a kitchen fitted with a sink, electric refrigerator and "Calor" gas water heater and at the other is an office. Electric points are fitted throughout.

*Kenwood demonstration caravan*

## Radio Show Attendance

The overseas attendance at this year's Radio Show at Earls Court, which closed on Saturday, exceeded 4,200, a record figure, despite the loss of three days (including the preview for overseas visitors) owing to the electricians' strike. Ninety-eight countries were represented. Last year the number of overseas visitors was 3,721. The total attendance during the eight days' run of the Show was 247,243 against 321,041 in ten days last year.

Mr. F. W. Perks, chairman of the Exhibition Organization Committee of the Radio Industry Council, said on Saturday that the fact that they had opened two days late did not seem to have had any important effect on the business done. The order books of many manufacturers of radio and television receivers were now full and there was a busy year ahead for the industry in meeting the demand for television sets.

## Electrical Equipment for Bar-and-Rod Mill

A contract has recently been placed with the Metropolitan-Vickers Electrical Co., Ltd., for the electrical equipment of a new rolling mill at the Stocksbridge works of Samuel Fox & Co., Ltd. It is for making high quality steel bars and rods for the ball-bearing and motor-vehicle industries, and the whole project will cost about £2½ million, of which the electrical equipment accounts for more than £300,000. Production will start in 1957.

The new mill, the mechanical parts of which will be built by the Brightside Foundry & Engineering Co., Ltd., will be the most up to date of its kind in this country. It will finish stainless steel rods of No. 5 gauge at speeds

exceeding 40 m.p.h., and the products will range from this size up to 2½in diameter.

The electric drive for the first three mill stands will be provided by a 1,500 h.p. a.c. motor, while the remaining fifteen stands will each have their own d.c. variable speed motor, these comprising four 200 h.p., five 350 h.p. and six 250 h.p. machines. The d.c. supplies will be provided by mercury arc rectifiers, and in view of the small metal sections and high metal speeds involved special control gear will be required to maintain the correct speed relationship between the mill stands.

There will be two flying shears, operating at metal speeds up to 850 ft/min and 1,800 ft/min respectively, and these also will be of special interest from the control gear point of view.

## Thermodare Developments

A large central store has been opened at Uxbridge by Thermodare (Great Britain) and the firm now has its own transport service for the whole of the London and Home Counties area. The storage heaters are not only just delivered but are placed in position ready for connection, a consideration with these weighty articles. Another introduction is a shelf unit for use with all Thermodare heaters, enabling the space over the heater to be used for books, files, etc.

*Thermodare shelf unit*

## English Electric Plant for Pretoria

A contract for two 30 MW steam turbo-generators for the Pretoria, South Africa, "B" power station has been placed with the English Electric Co., Ltd., which has already supplied four similar sets to the station.

## Overseas Visitors at Rugby

The Governor of Mosul, His Excellency Rashid Bey Najib, accompanied by Mr. J. A. Newton, chief electrical engineer of the Iraq Petroleum Co., recently visited the Rugby works of the British Thomson-Houston Co., Ltd. The guests were entertained by Mr. G. S. C. Lucas (director and chief electrical engineer) and senior executives of the company. During a very full day they toured the main works and the lamp works.

*Front row: Mr. R. M. Grant (manager, B.T.H. plant contracts, Rashid Bey Najib, Messrs. G. S. C. Lucas, J. A. Newton and C. K. Bird (manager, B.T.H. turbine contracts). Back row: Messrs. C. W. Peyton (B.T.H. Export Co.) and J. G. Boddy (deputy manager, B.T.H. turbine contracts)*

## Italian Towers for New Zealand

The New Zealand Hydro-Electric Department has placed two orders for transmission line towers with an Italian company. The towers are for the lines connecting the Wairakei geothermal station and the Whakamaru hydro-electric station and the Islington substation, near Christchurch, and Kikiwa, near Nelson.

## Fluorescent Lamp Colour Coding

A system of colour-coding for "Sieray" fluorescent tubular lamps is announced by Siemens Electric Lamps & Supplies, Ltd. Each particular type of tube has been given a packaging code-colour. "Daylight" is coded blue; "Natural" has a red sleeve. "New Warm White" and "De Luxe Warm White" are packed in mauve and green sleeves, respectively. Yellow sleeves contain "Colour Matching White" tubes. An advertising campaign supporting the new system is scheduled to commence on 15th September, and dealer code-charts and an explanatory broadsheet will be available from that date. The system is expected to be in full operation by early October.

## New Showrooms

The North Western Electricity Board has opened new showrooms, service centre and district offices at Penrith, Cumberland.

## Changes of Name

R. D. H. Thompson & Luckham, Ltd., have changed their name to R. D. H. Thompson & Co., Ltd.

The name of W. J. Thompson (Optical), Ltd., has been changed to W. J. Thompson (Electrical), Ltd.

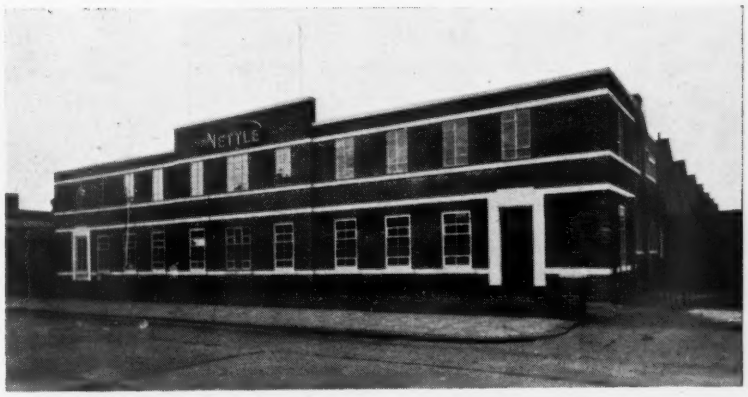
## Trade Announcements

As from 26th September the Private Telephone Department of **Siemens Brothers & Co., Ltd.**, will be transferred from Upper Thames Street, E.C.4, to new premises at Siemens House, No. 3, Avon Trading Estate, Avonmore Road, West Kensington, London, W.14 (telephone: Fulham 9471). Overseas and export orders are still dealt with direct from Siemens' Woolwich works.

The opening of a new sub-branch at Reading is also announced. As from 12th September the products of the group, including lamps, lighting equipment, telephones, cables and telecommunications, will be available from Cardiff Road, Reading, Berkshire (telephone: Reading 55030). The sub-branch manager is Mr. R. A. Hyde.

The head office and main works of **R.C.A. Photophone, Ltd.**, have been moved from Woodstock Grove, Shepherds Bush, to a modern factory at Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx (telephone: Sunbury 3101; telegraphic address: "Ircapp, Sunbury - on - Thames, Middlesex").

*The Wythenshawe factory of Nettle Accessories, Ltd., has recently been extended; the photograph shows the new building just completed*



# Aircraft Electrical Equipment

## S.B.A.C. EXHIBITION AT FARNBOROUGH

THIS year the combined flying display and exhibition of aeronautical equipment organized annually by the Society of British Aircraft Constructors at the Royal Aircraft Establishment, Farnborough, is being held from 5th to 11th September. As usual, electrical instruments and electronic equipment of one sort or another are prominent in the display of aircraft equipment and with the recently announced programme of rocket and satellite research it is evident that the mechanical stress on equipment of this nature is going to be more and more demanding.

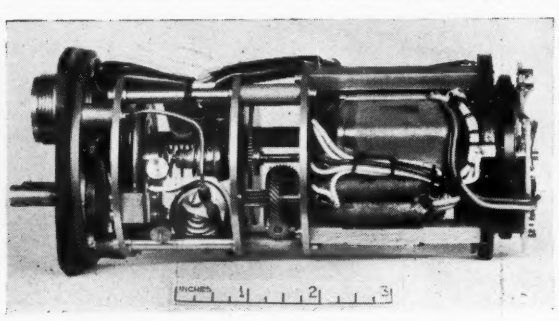
Imperial Chemical Industries, Ltd., show many metals and alloys including titanium, now available on a commercial scale, and also "Fluon," their polytetrafluoroethylene product. This plastic has a wide range of working temperature, is chemically inert, has a low coefficient of friction and non-wetting and non-sticking qualities. It is used for electrical and radar components, for non-corrosive flexible tubing, sheathing control cables, etc.

Aircraft cables such as "Pren" and "Nypren" are shown by B.I.C.C. including types with aluminium conductors. Also on show are ignition cables, radio frequency cables and miniature multi-way cables. Vibration generators and ancillary driving equipment are widely used in the aircraft industry for ground resonance and fatigue testing of structures, assemblies and metals, and such apparatus is shown by Goodmans Industries, Ltd., including two new instruments, the vibration generator model 16/600 and a power oscillator model D120.

The aircraft equipment division of the English Electric Co., Ltd., is placing special emphasis on alternating current electrical systems. The centrepiece of the display is a sectioned "Sundstrand" constant speed drive with an English Electric 40 kVA alternator. This was described in the *Electrical Review* of 25th February, 1955. The alternator provides an output frequency of 400 c/s constant to ±1 per cent and is air-blast cooled. Circuit-breakers, transformers and small motors for use with a.c. systems are shown, as are also actuators, generators, motors, etc., for use on existing d.c. systems.

A new form of aircraft starting system of the liquid fuel type, simpler in design and smaller in weight than any previous type of starting system, has been developed and is being shown by the British Thomson-Houston Co., Ltd. The fuel used is mono-fuel iso-propylnitrate (ipn). High-speed gas turbine type starters have been extensively developed since the last war and are eminently suitable for starting gas turbine engines. Up to now these starters have used gases under pressure provided from a cartridge. Cartridges have definite limitations especially as the size of engines tends to grow and this latest development uses ipn because no air is required for its combustion. A small cartridge is still used to initiate the fuel injection and the electric current also required during initiation has been reduced to less than 1 A per start, so that in a multi-engined aircraft all the engines can be started simultaneously without a heavy demand upon the aircraft battery. The B.T.H. is also exhibiting a range of ignition units, aircraft motors and auxiliary generating plant. The Plessey group of companies also exhibit ipn type starters as well as a pneumatic turbine type. They show a new rationalized Jaguar actuator capable of replacing a variety of previous types. It is driven by a split-field series wound motor developing 0·03 h.p. at 15,000 r.p.m. which incorporates a disc type electro-magnetic brake to limit over-run. Three new ranges of relays with an improved magnetic circuit design are also shown by Plessey. The Telegraph Construction & Maintenance Co., Ltd., shows a representative range of high-frequency, telecommunication, multi-core aircraft cables and control cables together with a series of plugs and sockets, etc. "Telcathene" mouldings possessing high electrical insulation properties are demonstrated: this material contracts appreciably on cooling from the viscous state, thus ensuring that any metal inserts are firmly located in position.

*Kelvin Hughes airspeed sensing unit for audio approach system*



*Left: Marconi control and display unit for v.h.f. direction finder and (right) Salford Electrical Instruments metal-housed precision potentiometer*

An analogue computer has been produced and is on show by Short Bros. & Harland, Ltd., and is designed for general application in industry and research. It is capable of rapidly completing calculations of stress analysis, controlling surface flutter and other problems connected with aeronautical engineering. This company also exhibits high-frequency electric motors whose magnetic circuits are composed of solid blocks of ferrite material. At frequencies above a few hundred cycles this material has the advantage of a complete absence of any current losses, light weight, easy machineability into intricate shapes and electrical non-conductivity.

An air rescue tender manufactured by Fire Armour, Ltd., based on an Austin 4×4 chassis, carries a 5 kVA 110 V a.c. generator and two Black & Decker air rescue saws powered by 2 h.p. 110 V universal motors, in addition to the more normal equipment of such a vehicle.

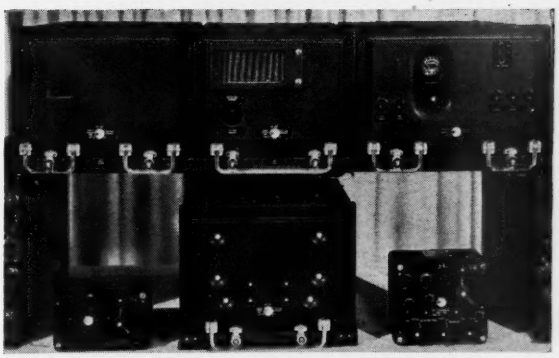
A number of firms display batteries and accumulators including Venner Instruments, Ltd., Chloride Batteries, Ltd., Peto & Radford, Ltd., and Oldham & Sons, Ltd. Emphasis is placed by all these makers on the lightweight

construction of their various types. The Westinghouse Brake & Signal Co., Ltd., show a comprehensive selection from their range of copper oxide and " Westalite " rectifiers and germanium diodes. An interesting feature is an aluminium based rectifier developed for aircraft d.c. power supplies and having a much lower weight/power and volume/power ratio than the types of " Westalite " rectifier at present installed in many aircraft.

A difficulty experienced by pilots when landing on aircraft carriers is that they wish to observe the batman and also to keep an eye on their air speed, which means continual re-focusing of the eyes. Kelvin & Hughes have developed an air-speed sensing unit which presents to the pilot a definite sound pattern corresponding to the speed of the aircraft above or below the fixed approaching speed. The system has been developed in conjunction with the Ministry of Supply and the R.A.F. Institute of Aviation Medicine and is accurate to 0·25 knot at 110 knots.

As usual a large number of stands are concerned with electronic equipment and four of these are occupied by Marconi companies. Among their exhibits is a new sub-miniature automatic direction finder, a radio compass which is believed to be the smallest and lightest equipment of its type and which is intended for pilot operation in fighter and small civil aircraft. Emphasis is placed by Smiths Aircraft Instruments, Ltd., on a new flight system in which the functions of 16 instruments are condensed into 8 standard size panel mounted indicators in which switching and setting operations have been reduced to the minimum. The system includes an automatic pilot and a new twin compass for automatic flight conditions. It is a surprising fact that economically a decrease of one per cent in the allowed tolerance for inaccuracies of measurement for fuel capacity can on a large turbine airliner represent the weight of about three passengers. Every step toward 100 per cent accuracy is therefore highly desirable and Smiths are showing instruments for fuel flow measurement and fuel tank contents measurement. Redifon, Ltd., are showing a complete radio tele-printer terminal with facilities for the alternative use for telegraphy or telephony, and each can be used with any standard tele-printer. Another exhibit is the new Redifon G142 medium frequency locator beacon and route marker. A dual installation being shown comprises two transmitters, each with a power unit and a change-over device which automatically switches on the reserve transmitter should the one in use not radiate correct signals at the full carrier power with adequate modulation.

A tactical air navigational aid capable of giving bearing and slant line distance to a number of aircraft relative to a fixed ground station and with a normal maximum range of 200 nautical miles is the " Tacan " system of Standard Telephones & Cables, Ltd. This operates at 1,000 Mc/s. The ground and airborne equipment associated with this can be seen on this company's stand. Mullard, Ltd., have developed a new 5in radar tube of very high brightness for use at high altitudes with a correspondingly high ambient light level. Other exhibits are a high-speed



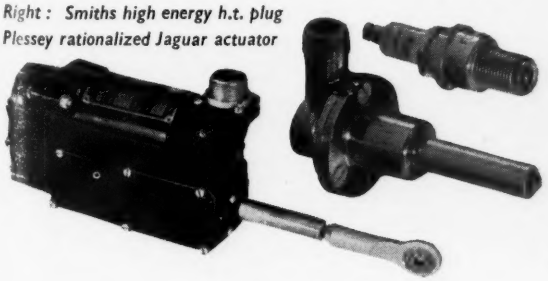
*Marconi multi-channel self-tuning h.f. transmitter/receiver*

*Airfield light rescue vehicle equipped with Black & Decker rescue saw*

binary counter, an electronic timer and a loud hailer using transistors, which is essentially a normal megaphone and in actual fact contains batteries, a microphone, an amplifier and a loudspeaker. A new variable frequency audio oscillator is shown by Salford Electrical Instruments, Ltd., and among further exhibits by this company is a recently introduced metal-housed precision potentiometer incorporating a new wiper and slip-ring design. Ekco Electronics, Ltd., exhibit their new high power search radar equipment which can detect cumulo-nimbus clouds up to 120 miles away, distinguish between dangerous and non-dangerous cores in such clouds and has a high brightness display. Ferranti, Ltd., have on view a hit indicator designed to assist the rapid and accurate assessment of scoring during gunnery training from or at aircraft, the gyro gunsight and also a diagrammatic display of the Ferranti system for the electronic control of machine tools.

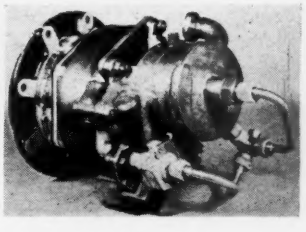
A completely new ground radar is being presented by Decca Radar, Ltd., known as the type MR75. It offers a medium range air surveillance radar with solid vertical coverage out to approximately 45 miles up to 25,000ft on a small jet aircraft; it costs less than £20,000.

*Right : Smiths high energy h.t. plug*
*Plessey rationalized Jaguar actuator*



*Venner silver-zinc accumulator in power pack for guided missiles*

*The new B.T.H. liquid fuel aircraft starter*



**WORLD ELECTRICAL MARKETS**

# *Electricity in Portugal*

## Present and Prospective Development

By V. P. CRUZ and E. GENTIL CORDEIRO (Electrical Engineers, Lisbon)

PORTUGAL is a country with small fuel resources; hence preference was given, when planning the production of power, to hydro-electric plants. The Electrification Bill, issued in 1944, is the fundamental legislation for the country's electrification. But because of the instability of the production of the hydro-electric schemes, which can be greatly reduced in drought years, the Government included in the six-year Development Plan, in addition to the £31·5 million allocated to the several hydro-electric plants under construction, £3 million for thermal power plant.

The National Load Dispatcher co-ordinates the production of 92 per cent of the power generated in Portugal and, during favourable rainfall periods, orders the thermal plants to shut down; they operate therefore as reserve and supporting plants.

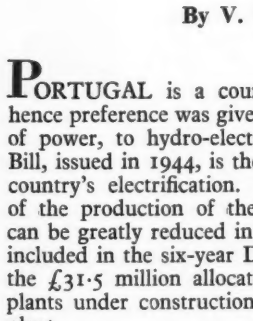



*Fig. 1.—Growth of Portuguese power plant capacity*

During the last 25 years the installed generating capacity increased as shown in Fig. 1. In 1951, with the inauguration of the first plants included in the electrification plan, the installed hydro-electric generating capacity was increased by 150 per cent compared with 1950 and the total generating capacity, in the same period, was increased by 60 per cent.

Fig. 2 shows the course of Portuguese consumption of electricity; it is a clear indication of the economic progress of the country in the past few years. The following section gives some particulars of the principal hydro-electric schemes in operation and under construction:—

The Zezere River hydro-electric concession was granted in 1945 to the Hidro Eléctrica do Zezere (HEZ) whose capital is shared by the Government, private supply companies, by the main industrial power consumers, and by the public. The Zezere River scheme is divided into four projects, the main features being given in Table I.

The concession for the Cávado and Rabagao scheme was granted in 1946 to the Hidro Eléctrica do Cávado (HICA), formed in the same way as the HEZ company. This scheme is also divided into four projects, one on the Rabagao River, and three on the Cávado River. The chief characteristics are given in Table II.

Vila Nova station with a generating capacity of 90 MVA in three units is fed by the Venda Nova project and a new 60 MVA group fed by the Paradela project is still under construction. Near the Caniçada station there is a switching station connecting at 150 kV all the incoming lines from Cávado and Rabagao system and two 150 kV outgoing feeders, connected to the Ermezinde substation (Oporto) of the Companhia Nacional de Eléctricidade (CNE).

The Tagus and Ocresa River schemes are being carried out by the Hidro Eléctrica do Alto Alentejo (HEAA) which already operates other systems. The Pracana station on the River Ocresa is in operation with an installed capacity of 17·6 MVA. The Belver project, on the River Tagus, has an installed capacity of 40 MVA. Other developments are the Lima River scheme in which the Lindoso station has an installed output of 87·5 MVA; the Serra da Estrêla scheme (47 MVA); the Ave River scheme (29·4 MVA); the Unhais River scheme (24 MVA); and the Douro River scheme (200 MVA).

There exist in Portugal six steam power stations with capacities of over 10 MVA, situated near the centres of consumption, as follows:—Freixo, Oporto (19 MVA); Massarelos, also in Oporto (11·3 MVA); Caniços, near Oporto (15·5 MVA); Tejo, Lisbon (74 MVA); Santos, Lisbon (14 MVA); and Cachofarra, Setubal (12·8 MVA). Massarelos is the only thermal station equipped to operate with low grade national coals; all the others are dependent on imported fuel.

To reinforce the existing steam power system, the Government included in the six-year plan (1953-58) a steam power station with an installed capacity of 62 MVA in one unit. The construction and operation of this steam station is in the hands of the Empresa Termo-Eléctrica Portuguesa, the shares being subscribed by the State, power producers, power supply companies and mining firms. The company is preparing the building plans and will soon send out inquiries for the supply of the plant which is expected to be in operation in 1957.

*Fig. 2.—Electricity consumption in Portugal, 1927–53*

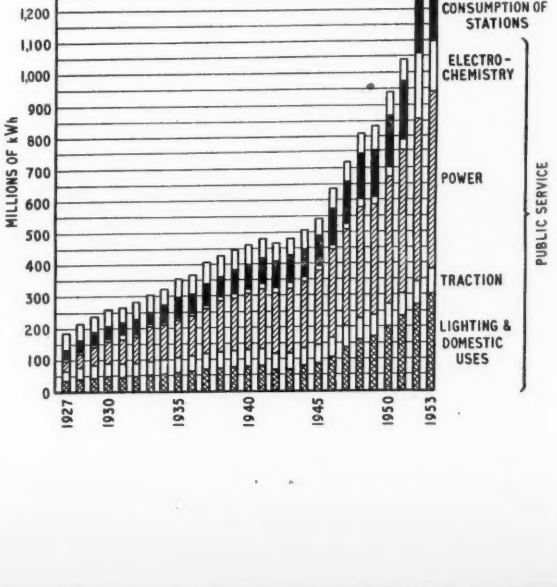


**TABLE I.—RIVER ZEZERE POWER SCHEME**

| Scheme | Height of dam | Capacity of reservoir | Average head | Installed capacity | Average annual output |
|---|---|---|---|---|---|
| | Feet | $m^3 \times 10^6$ | Feet | MVA | kWh × $10^6$ |
| Castelo do Bode (In operation) | 378 | 900·5 | 263 | 3×57·4 | 380 |
| Cabril (In operation) | 410 | 615 | 321 | 2×61 | 190 |
| Bouça (Under construction) | 214 | — | 178 | 2×28 | 140 |
| Constancia (Projected) | 39 | 2 | 23 | 3 | 20 |

**TABLE II.—RIVERS CAVADO AND RABAGAO POWER SCHEME**

| Scheme | Height of dam | Capacity of reservoir | Average head | Installed capacity | Average annual output |
|---|---|---|---|---|---|
| | Feet | $m^3 \times 10^6$ | Feet | MVA | kWh × $10^6$ |
| Venda Nova (In operation) | 318 | 94·1 | 1,300 | 3×32 | 232 |
| Salamonde (In operation) | 246 | 54·9 | 375 | 2×25 | 200* |
| Caniçada (Under construction) | 249 | 138 | 24 | 2×32 | 260† |
| Paradela (Under construction) | 345 | 140 | 1,475 | 1×60 | 260 |

* Also controlling the Paradela dam.
† When controlling the four reservoirs of the scheme.

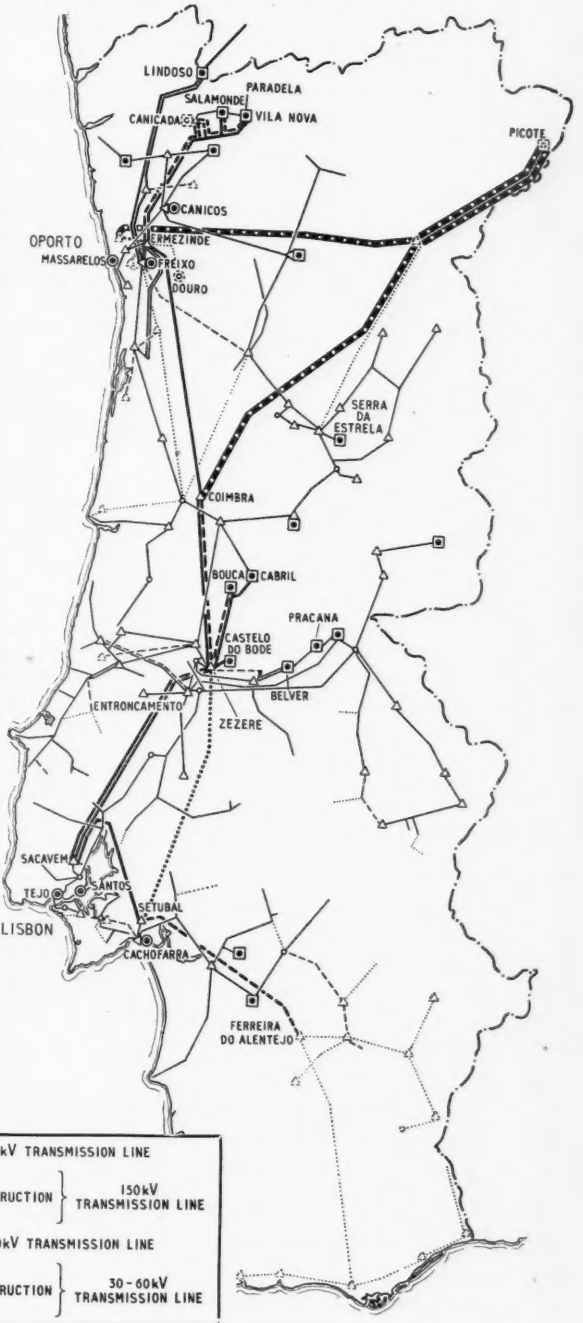
In Portugal, the main transmission is at 150 kV and 130 kV and the grid system is shown in the accompanying map. The 150 kV feeder circuit-breakers are of high-speed operation and equipped for single-phase auto-reclosure, with dead time (arc extinction to contact reclosure) ranging from 0·8 to 1 sec. The same circuit-breakers of Metropolitan-Vickers and Brown Boveri manufacture are equipped for three-phase high-speed auto-reclosure, with dead time of 0·2 sec. Circuit-breakers of Delle manufacture are prepared to receive a second interrupter unit permitting three-phase high-speed auto-reclosure.

Under the six-year development plan CNE is going to construct 112 route miles of 220 kV transmission lines to transport the power generated by the first stage of the Douro scheme between Picote and Coimbra substations and another 45 route miles of 150 kV transmission line to connect Coimbra with the Zezere substations. Tenders will be invited for the construction at Coimbra of a sub-station for 220/150/60 kV which will interconnect the Douro system with the 150 kV main grid and with regional distribution networks. Inquiries have already been sent out for two three-phase 220/150 kV, 120 MVA auto-transformer banks.

The Companhia Portuguesa dos Caminhos de Ferro is starting the electrification of its lines, using the overhead h.v. single-phase 50 c/s system. The first stage is the electrification of the Sintra and North lines (between Entroncamento and Lisbon), 90 route-miles of double track and 4 route-miles of single track. The company has already placed orders for 15 locomotives (type B.B. of 68 metric tons), 25 motor coaches for suburban service, the erection and equipment of two substations at Sacavem and Entroncamento, the supply and erection of traction wires, and the installation of the signalling and tele-communications system.

For the Baixo Alentejo and Algarve provinces rural electrification, the Companhia Eléctrica do Alentejo e Algarve (CEAA) has been formed. This concern will take energy from the CNE grid. The CNE will construct 60 route-miles of 150 kV transmission line and a 150/60 kV substation at Ferreira do Alentejo. The CEAA network is already planned; it will consist of several distribution lines at 60, 30, 15 and 6 kV and a number of substations.

The hydro-electric stations under consideration for future construction are mentioned in Table III. Their total installed power will be 1,480,000 h.p. and their average annual power production 4,646 million kWh. Of




*Portuguese grid system showing lines operating at 30 kV and over*

HYDRO-ELECTRIC GENERATING STATION
THERMAL " "
TRANSFORMER SUBSTATION
SECTION SUBSTATION
(DOTTED SYMBOL, UNDER CONSTRUCTION OR PLANNED)

PLANNED 220kV TRANSMISSION LINE
EXISTING
UNDER CONSTRUCTION
PLANNED
150kV TRANSMISSION LINE
EXISTING 130kV TRANSMISSION LINE
EXISTING
UNDER CONSTRUCTION
PLANNED
30-60kV TRANSMISSION LINE

**TABLE III.—STATIONS LIKELY TO BE BUILT DURING THE NEXT 10 OR 20 YEARS**

| River | Power station | Generating capacity thousand h.p. | Average annual output kWh × $10^6$ |
|---|---|---|---|
| Douro Internacional | Miranda | 170 | 640 |
| | Bemposta | 150 | 550 |
| Douro Nacional | Pocinho | 60 | 245 |
| | Valeira | 102 | 420 |
| | Régua | 105 | 435 |
| | Carrapatelo | 150 | 620 |
| Sabor | Sabor | 84 | 121 |
| Coa | S. Caetano | 20 | 45 |
| | S. Monforte | 90 | 200 |
| | Sta. Comba | 120 | 250 |
| Távora | Vilar | 5 | 10 |
| | Tabuaço | 60 | 120 |
| Paiva | Reiriz | 14 | 30 |
| | Fragas da Torre | 150 | 270 |
| Tejo | Fratel | 70 | 190 |
| Ocreza | Alvito | 130 | 500 |
| TOTAL | | 1,480 | 4,646 |

**TABLE IV.—PROBABLE TRANSMISSION LINES DURING THE NEXT 10 OR 20 YEARS**

| Voltage | Designation | Under construction or study km | Foreseen km |
|---|---|---|---|
| Lines at 220 kV | Picote—Pocinho—Porto | 180 | 200 |
| | Picote—Valeira—Porto | | 200 |
| | Picote—Pocinho—Coimbra | | |
| | Coimbra—Lisboa | | 220 |
| | Pocinho—Alvito—Lisboa | | 340 |
| | Miranda—Picote | | 20 |
| | Sabor—Pocinho | | 20 |
| Lines at 150 kV | Stubal—Ferreira do Alentejo | 90 | |
| | Cabril—Bouça—Zezere | 50 | |
| | Bouça—Zezere | 40 | 40 |
| | Salamonde—Caniçada—Ermezinde | 70 | |
| | Caniçada—Leça—Ermezinde | | 80 |
| | Coimbra—Zezere | 75 | |
| | Zezere—Setubal | | 120 |
| | Zezere—Benfica—Sacavem | | 130 |
| | Alvito—Fratel—Zezere | | 70 |
| | Carrapatelo—Porto | | 80 |
| | Vilar—Tabuaça—Régua—Ermezinde | | 130 |
| | Régua—Carrapatelo | | 40 |
| | Reiriz—Fragas da Torre—Carrapatelo | | 40 |
| Lines at 60 kV | Central Térmica—Ermezinde | | 15 |

these 16 stations 14 will be constructed in the Douro basin by the Hidro Eléctrica do Douro. The Fratel and Alvito central stations, with a total capacity of 200,000 h.p. and an average annual power production of 690 million kWh will be built by HEAA.

The Alvito dam is projected as a regulation reservoir to be filled with water pumped from the Tagus, using the energy available in the Douro system during heavy rainfall years; its construction depends upon economic considerations.

To transmit the power produced to the consumption centres, interconnect the stations and form closed networks to increase operating safety, the construction of the transmission lines given in Table IV is contemplated, with substations to interconnect the several systems.

Portuguese production of electro-mechanical equipment is still small. The Portuguese industry is able to manufacture penstocks, water-gates, grids and servo-machines; power and distribution transformers, up to 1,500 MVA and 30 kV; current transformers and voltage transformers for systems up to 1,000 V; several types of l.v. motors up to 65 h.p.; solid type armoured cable for up to 30 kV; multi-core cables of various types of conductors for up to 1,000 V; stranded bare copper conductors, copper tubes, steel reinforced aluminium cables and galvanized steel cables; h.v. pin-type insulators, apparatus insulators, l.v. insulators, etc.; arcing rings, yokes, suspension clamps, strain clamps, clevises, hooks, links, ball sockets, etc.; single-phase watthour meters; and oil circuit-breakers up to 30 kV with symmetrical breaking capacities up to 600 MVA.

"SOPREL," licensed by Ateliers de Constructions Eléctriques de Charleroi, intends to manufacture locally small-oil-volume circuit-breakers up to 220 kV operating voltage and of symmetrical breaking capacities up to 5,000 MVA.

"The British Group" (Metropolitan-Vickers Electrical Export Co. and English Electric Export & Trading Co.) supplied all the electro-mechanical equipment for the power stations of Castelo do Bode and Cabril of HEZ, all the equipment for the Vila Nova station of HICA and all the equipment, except the power transformers, for the Zezere substation of CNE. British Insulated Callender's Construction Co. installed the first 150 kV line built in Portugal, connecting Zezere to Lisbon, 70 miles long.

Constructions et Entreprises Industrielles, a Belgian firm, installed a 150 kV transmission line between Vila Nova power station and Ermezinde substation. The Compagnie Générale d'Entreprises Electriques (France), erected the 150 kV transmission line between Ermezinde and Zezere substations and a 150 kV transmission line between the Zezere and Sacavem substations, and supplied and installed the substations of Ermezinde and Setubal.

Brown, Boveri & Co. (Switzerland) supplied all the equipment for the Sacavem substation except the power transformers (which were supplied by Ferranti, Ltd.) and the electro-mechanical equipment for the Salamonde station of HICA.

The Ateliers de Constructions Eléctriques de Charleroi provided the electrical equipment for the power station and substation at Belver and the power transformers for the Ermezinde and Zezere substations. Siemens-Schuckertwerke, supplied all the equipment for the Bouça station. Comptoir Métallurgique Luxembourgeois supplied the steel for the transmission towers and Aluminium Union, B.I.C.C. and Svenska Metallverken provided steel-reinforced aluminium cables. The carrier equipment for the CNE grid was supplied by Brown, Boveri & Co., and the P.B.X.s and telephones were supplied by Automatica Eléctrica Portuguesa, S.A.R.L.

Tenderers for Portuguese contracts should clearly specify the characteristics of the equipment such as tests, guaranteed efficiencies, performance, etc. They should also include detailed prices, deliveries, and payment conditions. Prices are usually f.o.b. or c.i.f. British equipment is dearer than European equipment; power transformer costs are 25 per cent higher than the average European prices and considering the whole of the equipment for stations and substations British prices are 30 per cent higher than the average European costs. In Portugal British equipment is considered to be "strong and ugly." For the same purpose, British-made apparatus is more robust and heavier than the European equivalent. In our opinion, the British industry, in order to meet competition could modernize and save material without loss of efficiency.

European manufacturers are offering deliveries of about 16 months for large electro-mechanical installations; British firms quote longer periods. For large contracts payment conditions are usually arranged by mutual agreement. In some cases the payment terms are one-third of the total with the order, one-third when the material is ready for shipment and the balance three months later. In other cases a quarter is paid three months after the order, a quarter nine months after the order, a quarter when the material is ready for shipment and the balance after the material has been put into service, and not later than six months after shipment.

# Railway Electrification

## WORK ON THE CHELMSFORD-SHENFIELD-SOUTHEND LINE

*Concrete mixing and placing unit general assembly. Cement and aggregate trucks fore and aft of concrete mixing and placing unit. Diesel-electric power plant opposite second mast*

LAST week we had the opportunity of seeing something of the early constructional work on the Chelmsford-Shenfield-Southend electrification scheme. The work was started on this scheme on 1st March this year and the Chelmsford-Shenfield section is expected to be completed in time for the operation of the summer time-table of 1956 while the Shenfield-Southend section should be completed by early 1957.

The scheme as a whole represents a total length of 30 route miles. The electrical system is to be the same as that of the existing Liverpool Street—Shenfield section, namely, 1,500 V d.c. The British Thomson-Houston Co., Ltd., is responsible for the track substations, British Insulated Callender's Construction Co., Ltd., for the overhead feeding system and the General Electric Co., Ltd., for the new rolling stock. There are five track substations all fed from convenient points on the public high-voltage system. One substation is at Shenfield, another at Highlands on the Shenfield-Chelmsford leg, and there are three substations at Ramsden Bellhouse, Rayleigh, and Prittlewell, all on the Shenfield-Southend leg.

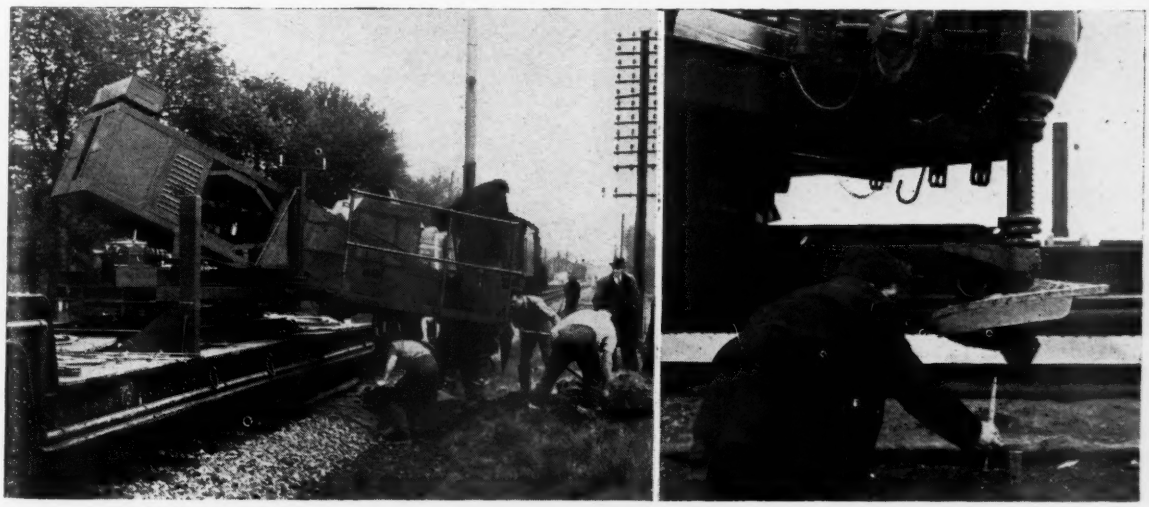
The present stage of the work is the erection of the steelwork for carrying the overhead system, that is, placing the uprights and fixing the cross booms in position. At the moment the steel uprights and cross booms are completed between Shenfield and Ingatestone, although the footings are already in beyond Ingatestone to Chelmsford. The work on the footings began with the old core box method but since work was started on the Shenfield-Southend section a new method has been introduced which has greatly speeded up progress.

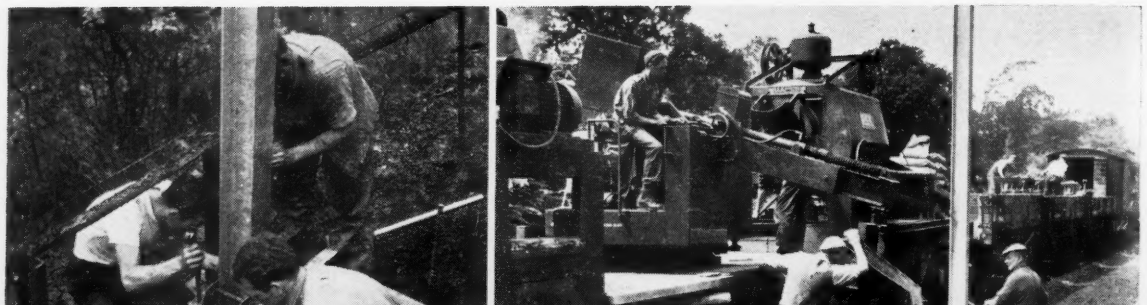
The contractors for the overhead work, British Insulated Callender's Construction Co., Ltd., have, in co-operation with Wharton Engineers (Elstree), Ltd., developed a new design of mechanical equipment by which the excavation of the holes for the masts, placing the masts in position and concreting the footings in, are all done in almost one continuous operation. In particular we saw this operation in detail on the line from Hockley to Rochford on the Southend section.

The holes for the foundations of overhead structures for electrification in this country have previously been excavated by hand, concrete materials being dumped and mixed on site. The erection of the masts and grouting-in have been separate operations which necessitated later visits to the site.

The equipment which is now being used makes it possible for all operations to be performed in sequence during one visit of the erectors to a section of which they have possession. A hole is bored in the ground by a mechanical auger, a temporary ground frame is placed over the hole and the mast is erected in the ground frame. Concrete, mixed on the train, is then poured into the foundation hole and the sequence of operations is complete. In this way a construction unit will enter a section of line on which no work has hitherto been done and in four or five hours will leave, having completed all the foundations

*Auger operating at normal boring distance from rail and (right) the drill centre is lined up on the location centre peg*





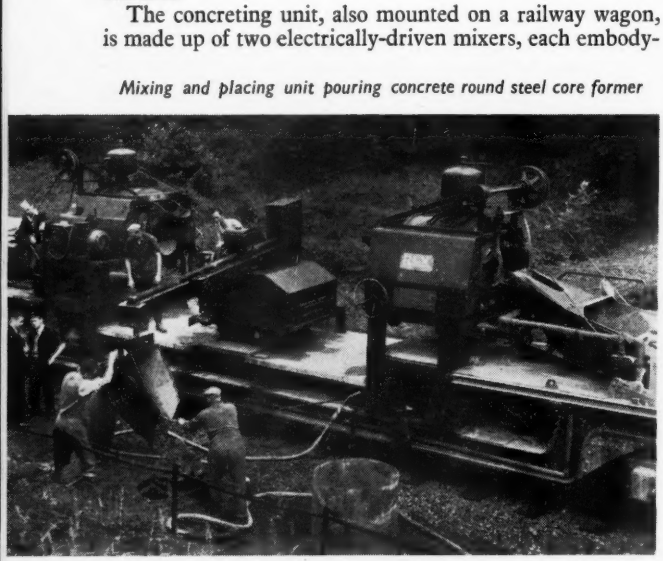
*Mast in position on ground frame; plumbing-up crew are tightening down and (right) pouring concrete into augered hole into which a mast has been set in a ground frame*

and erected all the masts on one side of one mile of track. The construction unit consists of three separate parts—the first part contains the earth-boring unit which proceeds to bore the holes as required, temporary ground frames being placed over the excavated holes. This is followed by the steelwork erection unit drawn by a self-propelled steam crane which lifts the masts into the excavations where they are held in the steel ground frames at their correct position and height. The third part is the concreting unit which fills the excavations.

The earth-boring unit consists of a boring head driven by a diesel engine, all mounted on a railway wagon. The unit can be made to travel along its own truck, to rotate about its axis, to traverse in an across-track direction, to be raised or lowered and to be adjusted to the vertical for any cant of track. In this way the unit can be quickly and accurately positioned. Holes measuring 2ft to 3ft 6in in diameter can be bored and the maximum depth of bore is 12ft. These holes can be bored up to a distance of 13ft 6in from the centre line of the track. So far as is known, no other augering unit has embodied all these features.

The concreting unit, also mounted on a railway wagon, is made up of two electrically-driven mixers, each embodying a batch weigher. Between the mixers is a specially designed placer unit which is electro-hydraulically operated. A telescopic jib enables the concrete, which is taken from each mixer in turn, to be placed in the hole. Power for driving the concreting unit is supplied by a diesel-electric generating set mounted on another wagon. This same wagon carries pumps for delivering water to the mixers and a rotary compressor for operating concrete vibrators and other tools.

*Mixing and placing unit pouring concrete round steel core former*



Where conditions are good, that is straight runs with good soil, the masts are mounted at 240ft spacing. On a section which we inspected 22 masts on one side of the track only were erected in a possession period of 4½ hours. Generally, a 2ft diameter hole is excavated for each ordinary suspension mast where the soil is sound, but in some places the soil conditions are such that the hole must be larger. There are augers available in sizes up to 3ft 6in diameter, but for holes larger than this the old method of hand excavation has to be employed.

## Arc Welding Electrodes

FOR many years now the "B.E.A.M.A. Guide to British Arc Welding Electrodes" has been the standard source of reference for those requiring information on metal arc welding electrodes manufactured in this country by members of the British Electrical and Allied Manufacturers' Association. Because of the rapid developments in arc welding it has been necessary to revise the Guide at frequent intervals and the latest edition contains a complete new section covering the wide range of special electrodes now available.

Information is included on electrodes for welding high-tensile steels, corrosion and heat-resisting steels, cast iron, aluminium and its alloys, bronzes, nickel and its alloys and for hard-surfacing. There are, in addition, notes on the application of these electrodes. There is no doubt that the inclusion of this new section will increase still further the usefulness of the Guide.

As before, it includes a brief description of the British and American classification systems for electrodes and summaries of the British specifications and Lloyd's regulations covering arc welding electrodes. There is also the up-to-date classified list of mild-steel electrodes showing the British and nearest equivalent American code numbers and any Admiralty, Ministry of Transport or Lloyd's approvals where such apply.

This edition has been completely re-written, and the new layout makes the information more readily available.

# Relaxation Solution Involving Refraction

## *Capacitances of a Three-Phase Busbar Trunk*

By J. WEBB, M.Sc.*

IN the article on capacitance calculations which appeared in the *Electrical Review*, 20th November, 1953, reference was made to the importance of contour integration used in conjunction with relaxation solutions. It was shown that the method could be used to calculate the capacitance of the concentric cable, parallel plate condensers, etc. These calculations were made simply to illustrate the method. In this article the same method will be used to find the capacitances of a three-phase busbar. It would be impossible to calculate these by orthodox mathematics.

A knowledge of the capacitances involved is of no tremendous significance; they are indeed extremely small. It will be admitted, however, that if a value of capacitance is obtained by the relaxation method, which bears a close resemblance to the value obtained by Schering bridge measurement, then the relaxation solution may be accepted as being a good approach to the final true solution. It will always be impossible to obtain this final true solution by relaxation methods, but this need not concern the engineer who, nurtured on the milk of tolerance and the crusts of compromise, will usually accept a solution which is within one or two per cent of the ideal. If then, relaxation solutions are acceptable because of their agreement with measured values of capacitance then these solutions may be used with greater confidence than would otherwise be the case, for the determination of voltage stresses in dielectrics. The calculation of voltage stresses is of vital importance so that relaxation solutions may be of real value to the designer.

As confidence in the methods grows it will be possible to predetermine the break-down voltage of complicated electrical gear while it is still "on the drawing board." The "test to destruction" will then be more confirmatory than exploratory as at present. The need for modification of the prototype after such tests should be greatly reduced. There is always a tendency to err on the safe side when producing a new design because of, to be candid, ignorance. Such designs will be robust and reliable, but they may also be more bulky than necessary and may therefore use up more costly material than is required for their intended rating. In this era of increasing competition, the designer cannot afford to neglect so powerful an analytical tool as the relaxation method. His electrolytic tanks should be used to yield trial solutions which, where possible, could then be improved by relaxation.

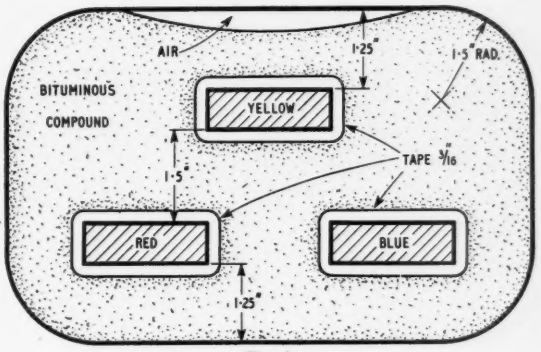



**Fig. 1**

Conductor dimensions 2in by 0·625in; length over busbars 2ft by 2·75in; length over casing 1ft by 11·25in; distance between inner faces of mouldings, each 0·5in thick, 1ft 8in.

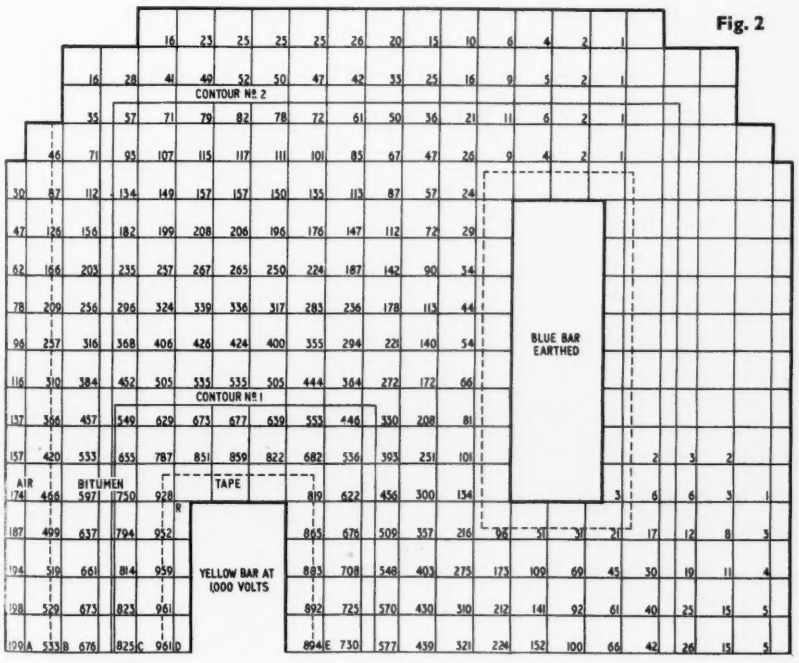
The three-phase busbar in which the conductors have triangular spacing is an ideal subject for treatment by relaxation methods. The different dielectric media present will cause refraction of the electric flux at each interface and this will make the solution more difficult of attainment and consequently more interesting.

Most of the details of the busbar trunk are given in Fig. 1. The dielectric constants are: bitumen 3 and tape 6. Certain assumptions had to be made before a solution was attempted; these are:—

(1) The dielectrics are homogeneous.
(2) The geometric alignment of the conductors is perfect.
(3) The rounded corners of the casing are replaced by a stepped boundary. This entails but little surrender of accuracy in capacitance calculations.

* College of Technology, Belfast.

**Fig. 2**



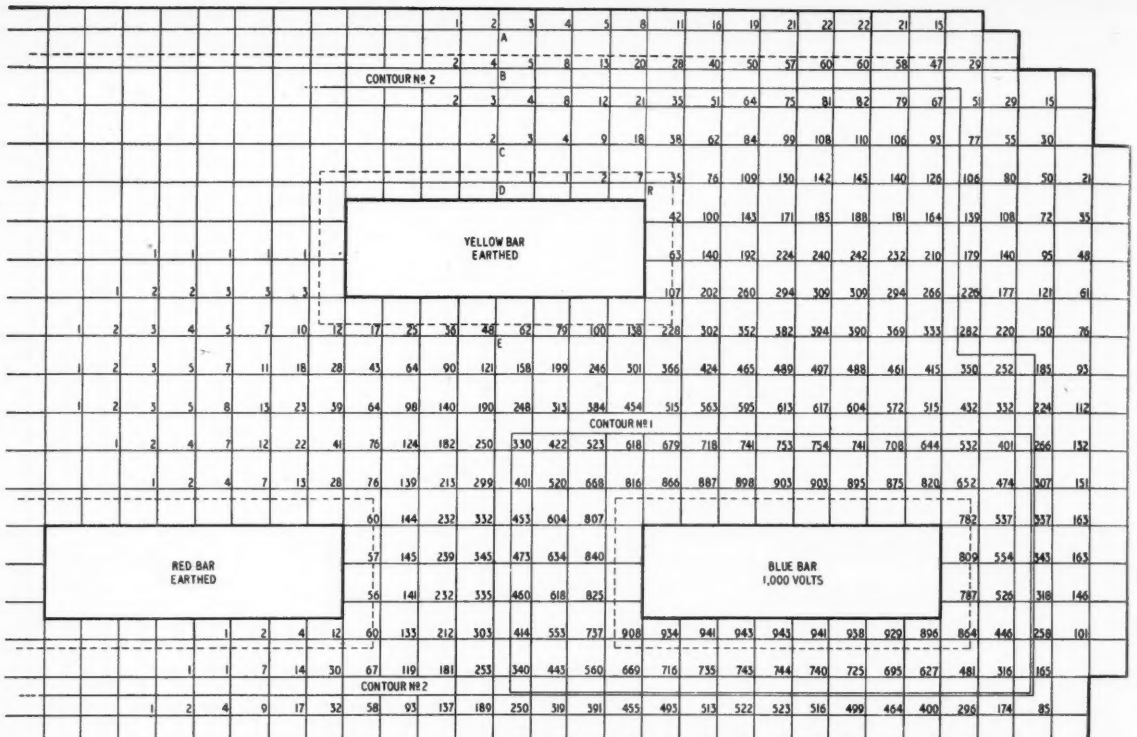



**Fig. 3**

(4) The expansion space above the bitumen is assumed to be $\frac{5}{16}$in from side to side, i.e. the top of the bitumen is assumed to be horizontal. This top surface is in fact curved but the writer has insufficient data.

(5) The busbar trunk is replaced by an equivalent trunk 2ft long. The Bakelite moulding is ignored.

(6) The potential distribution in the dielectric is governed by the equation

$$\frac{\delta^2 V}{\delta x^2} + \frac{\delta^2 V}{\delta y^2} + \frac{\delta^2 V}{\delta z^2} = 0$$

in which $\frac{\delta^2 V}{\delta z^2}$ is taken to be zero, and this must introduce an error since the trunk is only 2ft long. This error will decrease as the length considered increases.

(7) An adequate mesh length will be 0·25in.

## Solutions

The solutions are obtained as follows:—firstly, the yellow bar is charged to 1,000 V and the other two bars are earthed to the casing. In this instance there is symmetry in the potential distribution about the vertical centre line and consequently only one half of the domain (see Fig. 2) need be explored.

Next, the blue bar is charged to 1,000 V while the other two bars are earthed. There is no symmetry in the potential distribution in this case, and consequently the entire domain must be explored. (See Fig. 3.)

Various special equations are employed. The nodes, which are marked A, B, C, etc., in Fig. 3, are typical of those which require these special equations, which are derived from the geometry of the domain and a knowledge of the dielectric constants.

*Special Residual Equations*

$$F_A = 1{\cdot}92V_1 + V_2 + V_4 - 7{\cdot}12V_A$$
$$F_B = V_1 + V_2 + 0{\cdot}4V_3 + V_4 - 3{\cdot}4V_B$$
$$F_C = 1{\cdot}143V_1 + V_2 + V_3 + V_4 - 4{\cdot}143V_C$$
$$F_D = 5{\cdot}3333V_1 + V_2 + 1{\cdot}5238V_3 + V_4 - 8{\cdot}8572V_D$$
$$F_E = V_1 + V_2 + 1{\cdot}6V_3 + V_4 - 4{\cdot}6V_E$$
$$V_R = 2{\cdot}6666V_1 + 0{\cdot}4571V_2 + 0{\cdot}7619V_3 + 0{\cdot}5714V_4 - 4{\cdot}4571V_R$$

To explain here how these equations are derived, would elongate the present article unduly. Those interested are referred to the chapter on refraction in "Relaxation Methods in Theoretical Physics" by Sir Richard Southwell.

The solutions given in Figs. 2 and 3 are capable of further

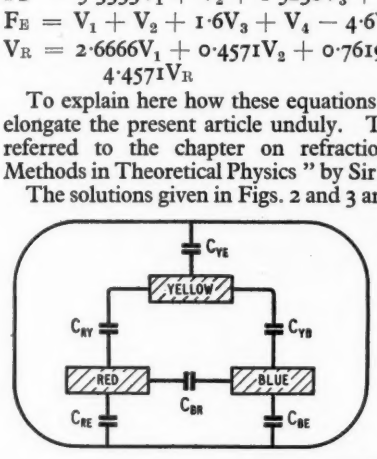



**Fig. 4**

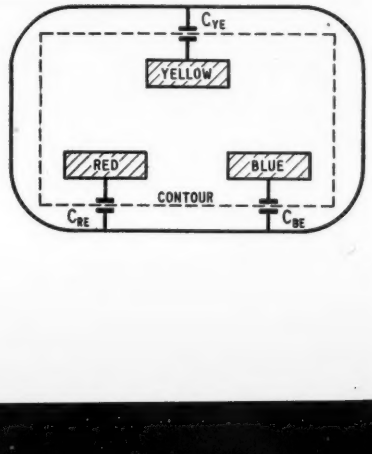



**Fig. 5**

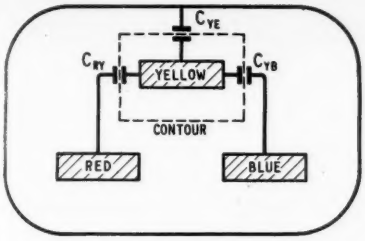



Fig. 6

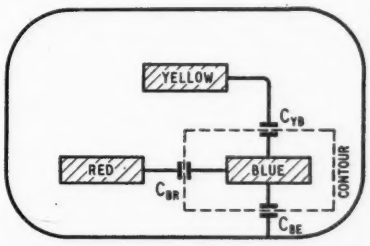



Fig. 7

reduction. Good values for capacitance may be obtained even when there is a considerable sum residual distributed over the domain. Relaxation is to some extent like tree climbing in that one gets a pretty good idea of the lie of the land without necessarily going right to the top.

The various capacitances involved in the busbar trunk are listed below. The list should be consulted in conjunction with Fig. 4.

$C_{RE}$:—the capacitance between red bar and casing
$C_{YE}$ „ „ „ yellow „ „
$C_{BE}$ „ „ „ blue „ „
$C_{RY}$:—the capacitance between red and yellow bars
$C_{YB}$ „ „ „ yellow and blue „
$C_{BR}$ „ „ „ blue and red „

These capacitances can be obtained by contour integration as follows. Refer to Fig. 5. Note that the contour (shown dotted) passes through regions in which the potential distribution is governed by the capacitances $C_{YE}$, $C_{RE}$ and $C_{BE}$.

If the red and blue bars are earthed, as they are in Fig. 2, then integration around such a contour will yield $C_{YE}$. If on the other hand B and Y are earthed then integration around the same contour will yield $C_{RE}$ ( $= C_{BE}$). This follows because the earth capacitance of a conductor is wiped out when that conductor is earthed. The contour should be taken around a path in which the dielectric constant does not change, if this is not done further unnecessary complications will arise.

Summation around the contour No. 2 in Fig. 2 yields 2,901, consequently

$$C_{YE} = \frac{3}{4\pi} \times \frac{24 \times 2{\cdot}54}{0{\cdot}9} \times \frac{2{,}901}{1{,}000}$$
$$= 47 \text{ pF}$$

TABLE I

| Capacitance Between | By Measurement | By Calculation |
|---|---|---|
| Red bar and casing (other bars earthed to casing) ... ... ... ... | 103·9 pF | 105·9 pF |
| Yellow bar and casing (other bars earthed to casing) ... ... ... | 89·7 pF | 87·9 pF |
| Blue bar and casing (other bars earthed to casing) ... ... ... ... | 101·1 pF | 105·9 pF |
| Red bar and casing ... ... ... | 75·8 pF | 77 pF |
| Yellow bar and casing ... ... ... | 53 pF | 47 pF |
| Blue bar and casing ... ... ... | 73·4 pF | 77 pF |
| Red and yellow bars ... ... ... | 19·13 pF | 20·45 pF |
| Yellow and blue bars ... ... ... | 19 pF | 20·45 pF |
| Red and blue bars ... ... ... | 9·9 pF | 8·45 pF |

*Explanatory Note*

$Q = \frac{K}{4\pi} \oint \frac{\delta V}{\delta n} ds$ E.S.U./$_{Cm}$ gives the charge included inside the contour. Now Q = C numerically, when V is unity. In the solutions offered V is 1,000, therefore to obtain C the approximation to $\oint \frac{\delta V}{\delta n} ds$ is divided by 1,000. (For further information see "Relaxation Methods," *Electrical Review*, 24th July, 1953). K for bitumen is 3 and the length of the trunk is 2ft. The 0·9 in the denominator is required to convert from stat-farads to $\mu\mu$farads.

Summation around the contour No. 2 in Fig. 3 yields 4,758, hence:—

$$C_{BE} = C_{RE}$$
$$= \frac{3}{4\pi} \times \frac{24 \times 2{\cdot}54}{0{\cdot}9} \times \frac{4{,}758}{1{,}000}$$
$$= 77 \text{ pF}.$$

It only remains now to obtain the values of the inter-capacitances $C_{RY}$ ( $= C_{YB}$) and $C_{BR}$.

In Fig. 6 the contour (shown dotted) passes through regions in which the potential distribution is governed by $C_{YE}$, $C_{RY}$ and $C_{YB}$. Summation around contour No. 1 in Fig. 2 yields 5,422.

Consequently:—

$$C_{YE} + 2\,C_{RY} = \frac{3}{4\pi} \times \frac{24 \times 2{\cdot}54}{0{\cdot}9} \times \frac{5{,}422}{1{,}000}$$
$$= 87{\cdot}9 \text{ pF}.$$

Since $C_{YE}$ is already known $C_{RY}$ may now be obtained:—

thus, $C_{RY} = \frac{1}{2}(87{\cdot}9 - 47)$
$= 20{\cdot}45$ pF ( $= C_{YB}$)

The remaining capacitance, viz., $C_{BR}$, may now be found by integrating around such a contour as that indicated in Fig. 7. This integration will yield $C_{BE} + C_{YB} + C_{BR}$ and is carried out in Fig. 3. The summation around contour No. 1 (in Fig. 3) gives 6,540, therefore:—

$C_{BE} + C_{YB} + C_{BR} = 105{\cdot}9$ pF.

and hence $C_{BR} = 105{\cdot}9 - 20{\cdot}45 - 77$
$= 8{\cdot}45$ pF.

Closer agreement would be obtained if the length considered were greater. The end errors are relatively great when such a short length (2ft) is being considered. The discrepancy is greatest between the two values for the yellow bar to casing capacitance. This is easily explained by the closeness of this bar to the air space. A small difference in the air gap will result in a relatively large difference in the capacitance of this bar in particular. The writer has no information regarding the exact shape of the curved surface at the top of the bitumen, consequently the discrepancy is more or less inevitable.

ACKNOWLEDGMENTS

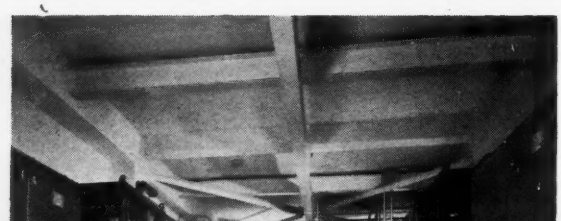
The author is indebted to Professor P. L. Burns, College of Technology, Belfast, for permission to reproduce some of the material which is used in this article, and also indebted to A. Reyrolle & Co., Ltd., who made the busbar data available and who carried out confirmatory tests at their Hebburn laboratories, and to Mr. C. H. Lackey, B.Sc., M.I.E.E., who took an encouraging interest in the work.

## The Automatic Factory

The Institution of Production Engineers has published a bound volume containing the papers presented at its conference last June on "The Automatic Factory—What does it mean?" together with reports of the discussions and a survey of the equipment exhibited. The volume provides a valuable background of factual knowledge on the subject. It is available from the Institution at 10, Chesterfield Street, London, W.1, price 25s.

# Variable Speed Dri

## The Respective Fields of Use



*Two Ward-Leonard geared lift drives rated at 3,750 lb at 200 ft/min (by courtesy of Pickerings, Ltd.)*

THERE are several methods of obtaining a variable speed drive from an a.c. supply. In this article, however, it is proposed to confine attention to two—the a.c. commutator motor and the d.c. motor with Ward-Leonard control—and to examine more closely than would be possible in a general article the various factors governing the choice of drive and the reasons for choosing one or the other type of drive in the case of numerous specific applications. Consideration is limited to powers from about 1 to 250 h.p., within which range both types are available.

With the a.c. commutator motor, either of two types may be used. There is the self-contained rotor-fed type, known as the Schrage motor, and the stator-fed type with external regulator. Both types need only a direct-on-line starting switch or contactor. It thus becomes necessary to compare three alternatives as illustrated by Fig. 1. Speed control is at the brushgear with (a), at the regulator with (b) and at the d.c. generator field with (c)—with additional control at the d.c. motor field if required. Infinitely fine speed variation is obtainable in all three cases and the range of speeds can be anything as desired although qualifications in regard to speed range are given later.

In general there is no best among these three methods and in a particular case there may be little to choose between them, or there may be outstanding advantages with one method. Each case must be determined on its merits.

### D.C. Motor with W.-L. Control

To obtain speed control with the Ward-Leonard system it is first necessary to convert the a.c. supply to d.c. using a motor-generator set. (It is also possible to use rectifiers but such departure from the original Ward-Leonard scheme is considered to be outside the scope of this article.) The output voltage from the d.c. generator is then applied to the armature of a separately excited d.c. motor and by varying the generator field current, output voltage and consequently the motor speed are also varied. To supply the fields of the d.c. machines and any control gear it is usual to direct couple an exciter to the m.g. set, although for small equipments a metal rectifier may replace the exciter and on very large equipments where the speed of the main m.g. set is low, a separately driven exciter set can be used with advantage. All the machines are of quite standard construction, the a.c. driving motor usually being a squirrel-cage or slip-ring type induction motor. Where power factor improvement is required a synchronous machine can easily be used instead.

It will be appreciated that a relatively small power is required to control the full power of the drive and this can be reduced still further, where necessary, by means of auxiliary exciters. With this system it is possible to use extremely sensitive and automatic methods of control, e.g., electronic and magnetic regulators, which enable a much higher degree of accuracy and rate of response to be obtained than is possible with other variable speed drives. Special speed-torque requirements can also be met

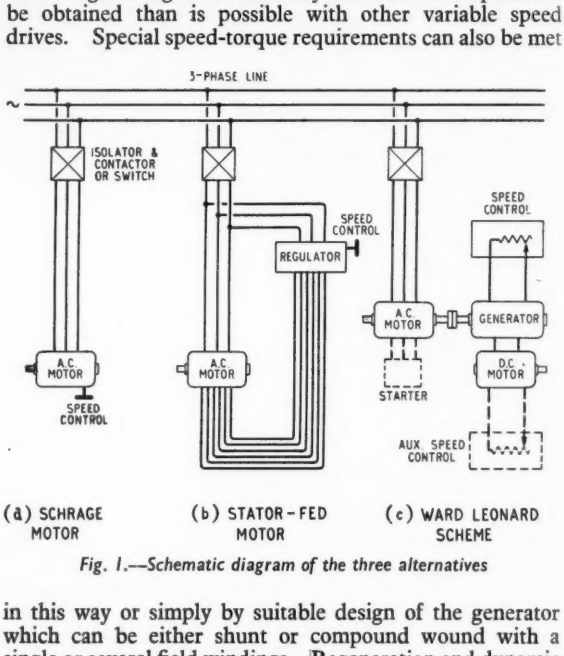



*Fig. 1.—Schematic diagram of the three alternatives*

in this way or simply by suitable design of the generator which can be either shunt or compound wound with a single or several field windings. Regeneration and dynamic braking are also easily provided for.

The Ward-Leonard system is thus extremely flexible and versatile and finds applications particularly where a high standard of performance is required.

### A.C. Commutator Motors

The Schrage a.c. commutator motor is essentially an inverted induction motor with an infinite number of no-load speeds. These speeds are obtained by feeding the secondary winding (in this case the stator winding) with slip-frequency voltages of any required magnitude. These injected voltages are obtained from the commutator on the rotor which acts as a frequency changer. The values of the voltages are determined by the distance apart on the commutator of brushes connected to the secondary phase-ends of the stator winding. The range of speeds is centred round the speed of the motor as an induction motor, i.e., when there is zero voltage fed into the stator.

# Drives

By A. C. LANE, B.Sc.(Eng.), A.M.I.E.E., and B. H. STOCKMAN, B.Sc.(Eng.)*

## of Use of A.C. Commutator Motors and the D.C. Motor with Ward-Leonard Control

Starting is done at the low-speed setting of the brush-gear. The value of the starting current is low for quite high starting torques. It may vary between half full load value for long range motors and twice full load value for short range motors. Speed variation is obtained merely by moving two brush-rockers in opposite directions around the commutator over a limited arc (one pole pitch).

The regulator-controlled stator-fed a.c. commutator motor is essentially a stator-fed induction motor, the secondary of which is connected to a commutator instead of to slip rings. The secondary voltages instead of being at slip frequency are therefore changed always to line frequency quite independent of the speed of the rotor. The infinitely variable no-load speeds are obtained by feeding the secondary with variable values of line frequency voltage with the correct phase relation to the secondary voltage, i.e., at the correct brush setting. Such voltages are obtained from an infinitely variable transformer or an induction regulator. Since the regulating device stands outside the motor the latter is able to be built with a smaller rotor which consequently has a lower inertia than a Schrage motor of the same rating. Also in the case of some motors especially of small ratings, the motor is more easily housed in a confined space. The motor brushgear is fixed once it has been set in the factory, and the motor is thus more versatile in its possible forms of enclosure. It is also able to be wound for voltages as high as an induction motor of comparable size.

### Choice of Drive

A great many drives require a horse-power proportional to the speed (i.e., constant torque). Others require a constant h.p. over at least part of the speed range in which case the size of the motor, whether a.c. or d.c., is necessarily larger than it would be in the former case, for the same h.p. at the top speed. With the Ward-Leonard system, however, the size of the m.g. set depends only on the maximum h.p., provided that shunt field control can be used for the main d.c. motor over the constant h.p. part of the speed range.

When deciding which type of drive to use factors which will need to be taken into account are: space requirements, cost, efficiency and power factor, maintenance, speed range and regulation, reversing and braking, accuracy and speed of response, and synchronization. The merits of each type of drive will therefore be discussed in relation to these eight factors.

As regards space requirements the size of a Schrage motor is appreciably greater than a d.c. motor of the same power and speed. The stator-fed a.c. motor may be slightly smaller than either of these but requires in addition a regulating device which needs to be mounted near the motor. The combined space of these two items will exceed the space required for the Schrage motor. With Ward-Leonard drives considerable space is also required for the m.g. set supplying the d.c. motor but this need not be near the motor and can be arranged in any convenient position. For smaller equipments where floor space is very limited the m.g. set can be mounted vertically.

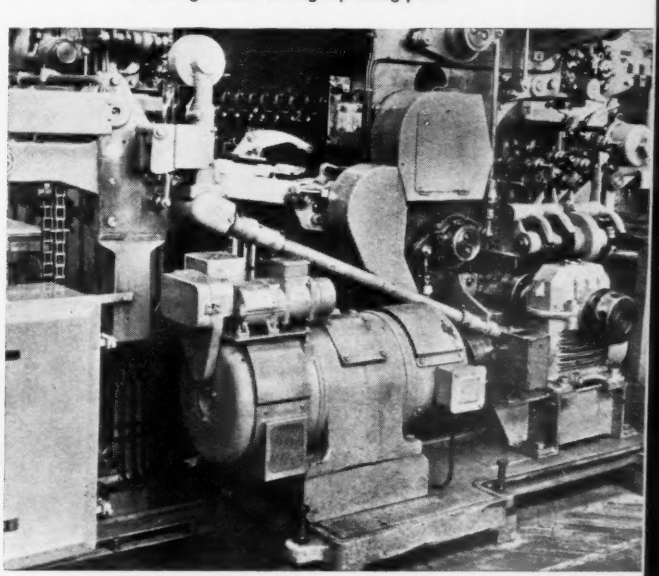
For straightforward drives of smaller power, the first cost of the Schrage motor, or stator-fed motor with its regulator, is less than the Ward-Leonard equipment. The difference decreases with increasing power and usually somewhere in the range of 150-250 h.p. the costs become equal, although this may occur at even lower h.p. ratings in the case of long speed range or constant h.p. drives. For more complicated drives, e.g., multi-motor sectional drives where each motor has to be kept in step with the others, the cost of the necessary auxiliary regulating gear may be greater with the a.c. commutator motor drives than with the Ward-Leonard system and therefore the latter may be cheaper in total cost. Each such case needs to be investigated in the light of the known requirements.

Both types of a.c. commutator motor have an efficiency greater than the overall efficiency of the three machines necessary with the Ward-Leonard system, but since, in the latter case, the efficiencies of the individual machines are higher than those of a.c. commutator motors, the difference is not as great as might be expected. To take a typical example, an 80/20 h.p. 4/1 speed range Schrage motor would have a full-load full-speed efficiency of about 85 per cent. The corresponding figure for the Ward-Leonard system (with individual machine efficiencies of 91-92 per cent) is about 76 per cent including excitation losses. The mere quoting of efficiencies for any particular condition of load and speed is inclined to be misleading where speed and load are varying considerably and in these cases an analysis should be made of relative power consumptions based on the actual or estimated duty cycle. If the standstill times for the drive are appreciable it can sometimes be arranged for the m.g. set of the Ward-Leonard system to be shut down and started up automatically when required to prevent power being consumed by it unnecessarily.

With regard to the power factor of a.c. commutator

* Mr. Lane and Mr. Stockman are members of the B.T.H. Motor Engineering Department.

*A Schrage motor driving a printing press*



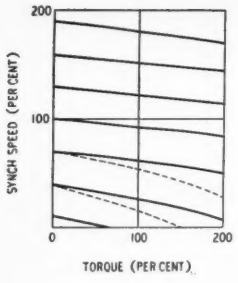



Fig 2.

*Fig. 2. — Speed-torque curves. Solid lines are for the Schrage motor; dotted for the stator-fed motor*

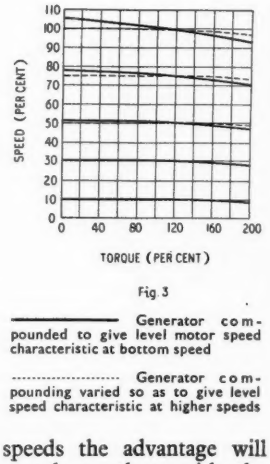



Fig 3

——— Generator compounded to give level motor speed characteristic at bottom speed

..... Generator compounding varied so as to give level speed characteristic at higher speeds

*Fig. 3. — Speed-torque curves for a shunt wound (separately excited) d.c. motor with Ward-Leonard control over 10 to 1 speed range (at full load) using a compound wound generator with rheostatic control of generator shunt field*

motors, at some loads and speeds the advantage will lie with the stator-fed motor and at others with the Schrage motor. Usually considerations of power factor will not influence the choice between these two types of motor. With the Ward-Leonard system using an induction motor the power factor depends on the load taken from this motor. Since its frame size is usually determined by the requirements of full load and speed at the drive, it tends to be operating at low loads and hence low power factor whenever the main drive is working at either reduced speed or load. Should this be a disadvantage a synchronous or compensated induction motor can be used instead to give unity (or leading) power factor throughout the operating range.

Maintenance of the a.c. commutator motor other than that necessary to bearings and to cleanliness entails attention to commutators and brushes, the rates of wear of which are dependent on motor size, duty and ambient conditions. Commutation is approximately uniform throughout the speed range with the Schrage motor, and with the stator-fed motor is best at synchronous and least favourable at greatest departure from synchronism. On motors up to about 100 h.p. commutation troubles are practically non-existent with either type of motor. At larger ratings, but again depending on the duty, the Schrage motor is more favourable on long speed ranges and variable duty, while the stator-fed motor is more favourable on short speed ranges and steady duty.

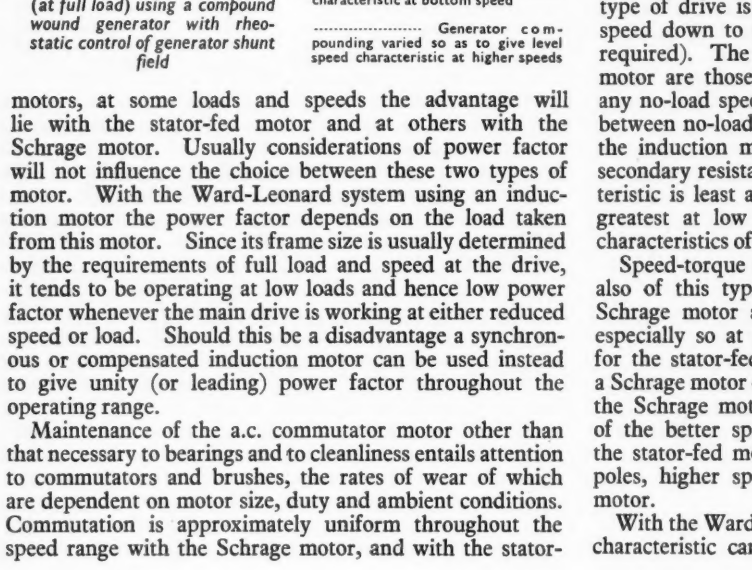
Similar maintenance routine is required for the Ward-Leonard machines. Since the d.c. voltage is independent of the supply voltage, a value can be chosen which gives single-turn armature windings for the main motor and generator, thus giving the best possible conditions for commutation. Provided reasonable attention is given to brushes and commutator long trouble-free periods (in many cases, years) of running can be obtained before it is necessary to renew brushes or grind commutators.

In speed range and regulation the chief contrast between the two types of drive is not so much in the degree of speed range obtainable but in the speed-regulation or speed-torque characteristics at the various speeds. Either type of drive is capable of a wide speed range from full speed down to a low inching speed (or to zero speed if required). The speed-torque characteristics of the Schrage motor are those of an induction motor assumed to have any no-load speed, but with the qualification that the slip between no-load and full-load is slightly greater than with the induction motor by reason of the increased internal secondary resistance. The steepness of this shunt characteristic is least at synchronism, greater at high speed and greatest at low speed. Fig. 2 shows the speed-torque characteristics of a typical long speed range motor.

Speed-torque characteristics of the stator-fed motor are also of this type, but are rather steeper than with the Schrage motor at speeds remote from synchronism and especially so at low speeds. The dotted lines of Fig. 2 for the stator-fed motor compare with the solid lines for a Schrage motor of identical rating. For long speed ranges the Schrage motor is usually to be preferred on account of the better speed regulation. For short speed ranges the stator-fed motor is capable of being built with fewer poles, higher speed and smaller bulk than the Schrage motor.

With the Ward-Leonard system any type of speed-torque characteristic can be obtained by suitable design of the generator or by the use of an additional regulating device controlling the generator field. Simply by using a compound wound generator, a flat motor speed-torque characteristic can be obtained at any speed within the range, or, by varying the compounding, at all speeds as shown in Fig. 3. The use of a generator with three field windings (self-separate shunt and differential series windings) gives speed-torque characteristics as shown in Fig. 4 which although reasonably flat over the working range, automatically limit the maximum torque to a safe value either with the motor stalled or on rapid reversal. By the addition of a suitable regulating device to control the field of a shunt wound generator, speed torque curves as shown in Fig. 5 can be obtained giving a flat regulation at any speed within the range and automatic current and torque limitation to any desired value.

*Components of a 50 h.p. Ward-Leonard equipment for planer drive*



When it comes to reversing and braking a.c. commutator motors generate if they are caused to run at a speed greater than the no-load speed at any point in the range. Therefore, regenerative braking is possible—but as far as low speed only—by reducing the speed, i.e., moving the brushgear, quickly enough. The efficiency of this regeneration is roughly equal to that of motoring at the same speed and torque values. Dynamic braking may also be achieved by plugging, i.e., reversing the primary with resistance switched into the secondary for current limitation. D.c. injection braking is also possible. The Schrage motor is reversible by a simple reversal of two of the primary line leads. Motors subject to very occasional reversal may also need re-setting of the brushgear, if the brushes have been set for one normal rotation. The stator-fed motor in small sizes is similarly reversible by simple change-over of two primary leads. Otherwise a reversing contactor is used in part of the secondary circuit, and the brushgear setting may need adjustment if it has been set for one normal rotation.

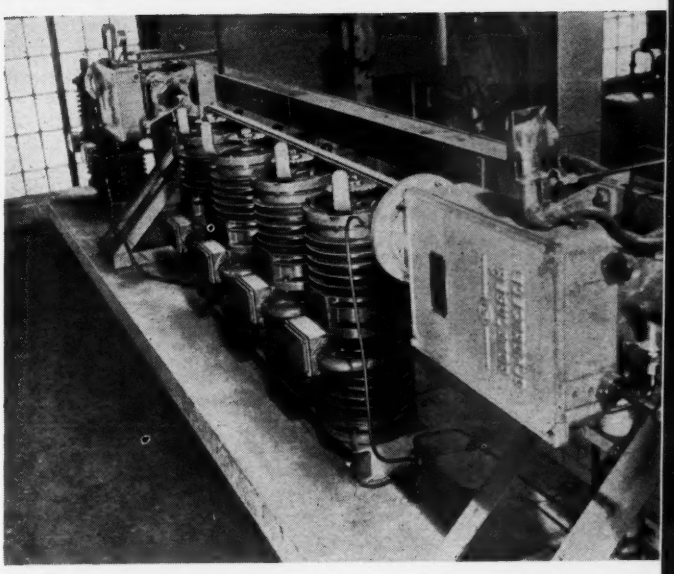
The Ward-Leonard system is inherently reversible and movement of the main motor in either direction is obtained simply by reversing the generator shunt field current. Regeneration occurs automatically when either the generator field is weakened or the motor has an overhauling load. The amount of regenerative braking and speed of reversal is controlled by the rate of change of the generator field or where necessary by an automatic regulator. For emergency stopping dynamic braking can be used in which case the motor is disconnected from the generator and a low resistance connected across the motor armature. A " plugging " reversal is quite feasible, the armature current and time of reversal depending mainly on the generator field time constant and the inertia of motor and load.

## Obtaining Accuracy and Rapid Response

Accuracy and response are often important in applications requiring a variable speed. With the Ward-Leonard system a very high degree of accuracy is readily obtainable by the use of automatic regulating circuits incorporating rotating, electronic or magnetic amplifiers controlling the shunt field of the main generator. High rates of response can also be obtained, assisted by the comparatively low inertia of the d.c. motor armature, which may be from one-third to one-tenth that of a Schrage motor of the same power and speed, and is similar to that of the stator-fed a.c. motor.

Synchronization has to be considered as with many multi-motor drives of the sectional type as used for paper, rubber and textile calenders, and for strip mills it is necessary to keep each motor in step and maintain a definite relationship between the strip speed or tension in each section. With the Ward-Leonard system this feature is obtained by varying the voltage applied to each motor in the same way, either by using a common generator or by coupling the field circuit or field regulators of individual generators. Control of tension is obtained by altering the armature current or field current of individual motors. Field control of the motor is also used in reeling operations to give variable reel speed for constant linear strip speed. The simplicity of this arrangement may give a lower total cost for the same result compared with an a.c. commutator motor drive where this has to be achieved in a more complex way.

There are many applications with single motor drive, where some degree of speed variation is required, which do not warrant the use of Ward-Leonard equipment as the duty can be performed satisfactorily by an a.c. commutator motor occupying less total space, with higher overall efficiency and possibly lower first cost. Such



*Coupled regulators for stator-fed motors driving mechanical stokers in a boiler house*

drives are those of fans, pumps, compressors, mixers, stokers, presses, centrifuges, conveyors, escalators, etc.

Excavators, winches and ore bridges make almost exclusive use of Ward-Leonard control because the duty requires a high rate of change of speed to give the maximum possible number of operations in a given time. It is also necessary that on meeting an obstruction the motor torque should increase but not beyond a definite limit which is safe for the drive; alternatively if the load is suddenly released the speed must not rise beyond a certain safe value. These requirements are ideally met by a combination of a low inertia d.c. motor and the speed-torque characteristics of Fig. 4 using a slightly modified form of Ward-Leonard system with a three-field winding generator.

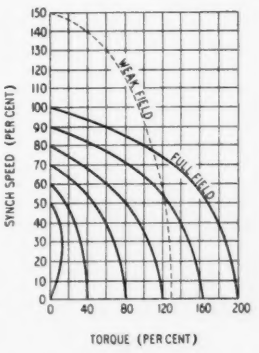



Fig. 4

*Fig. 5. — Speed-torque curves for a shunt wound (separately excited) d.c. motor with Ward-Leonard control over 10 to 1 speed range using a shunt wound generator with automatic regulator control of the generator field (incorporating IR drop compensation). Current limit set to give a maximum of 200 per cent torque*

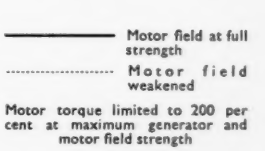

Motor field at full strength
Motor field weakened
Motor torque limited to 200 per cent at maximum generator and motor field strength

*Fig. 4.—Speed-torque curves for a shunt wound (separately excited) d.c. motor with Ward-Leonard control using a three winding generator with rheostatic control of generator separate shunt field*

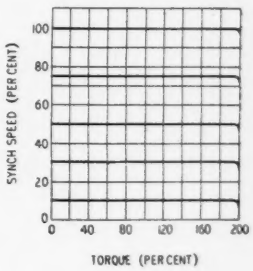



Fig. 5

Cranes generally have much simpler requirements and good use can be made of Schrage motors on all types. One essential property is the ability to give any speed within the range, in either direction and with any load.

Both Schrage motors and Ward-Leonard drives are successfully and extensively used for lifts. The choice is governed mainly by the following considerations. As gravity can assist or oppose motion, motor torque varies from full motoring to full generating value for either direction of motion. Accuracy of levelling depends on consistency of levelling speed (the lowest speed in the range) and therefore speed regulation at low speed is a determining factor. It will be seen by comparison of Figs. 2 and 3 that the Schrage motor has not such close regulation at low speeds as the Ward-Leonard system. Levelling speed has to be fixed within certain practical limits and therefore speed range increases with increasing top speed. As the top speed increases so does the acceleration necessary (assuming constant floor to floor distance) and low motor inertia consequently becomes of increasing importance.

In practice, therefore, the Schrage motor is used only for lift speeds up to about 300 ft/min with geared drives whereas the Ward-Leonard system with its better regulation at low speeds and lower inertia motor is used for high performance lifts up to 350 ft/min with geared drives or up to 700 ft/min with gearless drives.

For rapidly reversing machine tools, such as planers, where the duty requires good regulation at low speeds and easy control of reversing, and for special machines in which accuracy and speed of response are the over-riding requirements, the Ward-Leonard system is almost exclusively used, with or without automatic regulator control of the generator field. For non-reversing machine tools requiring variable speed such as lathes and balancing machines, the Schrage motor is best; for grinders of small size stator-fed a.c. motors are usual and have the advantages of compactness, and usually lower first cost. For larger sizes and where close speed regulation is required the Ward-Leonard system has advantages.

Paper, rubber and textile calenders, wire and strip mills involve the travel of the material at constant but controllable linear speed and with uniform tension. For the simpler types of drive using only a single motor the Schrage motor is very suitable. For the more complicated drives, often with individual motors on different sections of the traverse or where the wheels are centre driven, the Ward-Leonard system is usually simpler and better.

A form of Ward-Leonard control not yet mentioned, which has been used for arc furnace electrode control and also for radar, where a high rate of response and accurate position control are required, is one where a machine of the rotating amplifier type is employed as the main d.c. generator (instead of as an exciter controlling the field of a normal d.c. machine). Its chief advantage is in obtaining a high rate of response with exceptionally low power in the controlling field circuit, thus allowing metal rectifiers or electronic devices to be used for excitation and control.

In conclusion it is hoped that this article has shown the wide field of use in modern industry for both the a.c. commutator motor and the Ward-Leonard system, where a variable speed drive is required from an a.c. supply, and that the two methods are not so much competitive as complementary.

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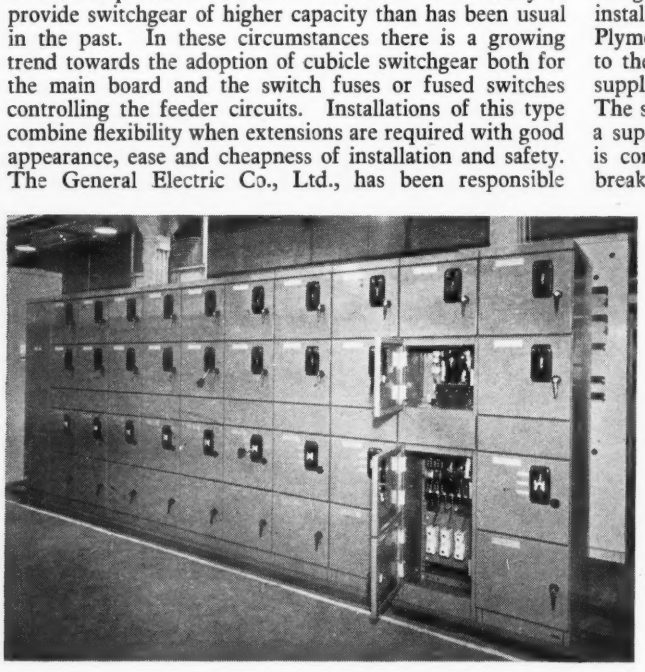
# Switchgear for Large Stores

INCREASING loads imposed by the many electrical services required in a modern store make it necessary to provide switchgear of higher capacity than has been usual in the past. In these circumstances there is a growing trend towards the adoption of cubicle switchgear both for the main board and the switch fuses or fused switches controlling the feeder circuits. Installations of this type combine flexibility when extensions are required with good appearance, ease and cheapness of installation and safety. The General Electric Co., Ltd., has been responsible for several installations of cubicle switchgear for stores in the group controlled by Debenhams, Ltd. In the typical installation illustrated, at the store of Spooners, Ltd., Plymouth, two supplies from different sources are taken to the main board. Alternative feeds, forming the main supply, are controlled by a 1,600 A oil circuit-breaker. The second circuit-breaker is of 400 A rating and controls a supplementary supply. Each cable of the main supply is connected through an off-load isolator. The circuit-breaker is arranged for vertical isolation by a hand-operated mechanism which is accessible when the isolators are open.



*Cubicle switchboard for control of feeder circuits and selection of alternative supplies at the store of Spooners, Ltd., Plymouth*

In the four-tier cubicle board controlling the feeder circuits, the two top rows of cubicles accommodate 22 fused switches which are normally connected to the main supply. Below these is a row of change-over switches which, in the event of the main supply being out of action, enable the supplementary supply to be connected through separate fuses in the bottom row of cubicles to a selected number of essential circuits sufficient to maintain the emergency services in the store.

The consulting engineer for the installation was Mr. A. W. Jervis, Associate I.E.E., F.I.E.S., and the contractors were W. G. Heath & Co., Plymouth.

# German Electrical Competition

## RECENT RAPID ADVANCE

By R. E. KAAN, Dipl.Ing.

FULL order books, increased productivity, reduced unemployment and enormous success in overseas markets, justify the optimistic outlook of Western Germany's electrical industry, a fact also reflected in its display at the recent Hanover fair. The significance of this economic resurgence, in spite of certain strains caused by the transition from a sellers' to a buyers' market, is best shown in Table I dealing with the basic figures of Western Germany's electrical industry.

Production, employment, foreign trade, incomes and the formation of capital—to mention only these—all show great increases. Prices, as is desirable in the interest of sound economic growth, not only in most cases remained stable, but showed a marked decline. Western Germany's yearly electrical exports continued to rise during 1954 and were not less than 35 per cent above the comparable 1953 figure. An analysis of the export trade is given in Table II.

Germany's latest foreign trade figures again reveal a persistent vigorous rise in exports. On the basis of value, the increase during the first five months of this year compared with the corresponding period of 1954 was 25 per cent and in terms of volume 11 per cent. As in 1954, because of the high rate of capital investment during recent years, production capacity expanded to such a degree that in spite of heavy home demand the acquisition of new markets abroad remained attractive. Competitive power was doubtless increased by the progress made in rationalization and rising productivity.

A comparison between United Kingdom and Western German electrical export distribution (see Table III) shows that Western Germany reduced the proportion of her exports sent to Continental Europe (still her best customer) and increased her business with overseas territories.

**TABLE I.—WESTERN GERMANY'S ELECTRICAL INDUSTRY (INCLUDING BERLIN)**

| | 1953 | 1954 | Inc. or dec. % |
|---|---|---|---|
| Production (£ million) | 571 | 701 | + 24 |
| Total employees | 405,328 | 460,652 | + 14 |
| Production per employee | £1,409 | £1,520 | + 9 |
| Export (£ million) | 105 | 141 | + 35 |
| Export as percentage of production | 18·5 | 20·1 | + 8 |
| Electrical exports as percentage of total exports | 7 | 7·5 | + 7 |
| Index of orders (1951 = 100) | 148 | 198 | + 34 |
| Index of Production (1950 = 100) | 168 | 224 | + 34 |
| Price index (1950 = 100) | 111 | 106* | − 5 |

* Provisional.

**TABLE II.—WESTERN GERMAN ELECTRICAL EXPORTS**

| Class of Goods | Values in £000 | | |
|---|---|---|---|
| | 1952 | 1953 | 1954 |
| Generators, motors and rotary convertors | 9,103 | 9,432 | 9,932 |
| Complete generating sets | 9,510 | 9,856 | 7,892 |
| Transformers | 3,670 | 4,031 | 4,562 |
| Accumulators | 1,623 | 1,411 | 1,826 |
| Household vacuum cleaners and floor polishers | 775 | 998 | 1,463 |
| Household washers, wringers and driers | 1,568 | 2,232 | 3,062 |
| Fans up to 600 W | 111 | 161 | 287 |
| Hairclippers and shavers | 287 | 382 | 816 |
| Ignition equipment for vehicles | 1,058 | 1,253 | 1,763 |
| Electrical equipment for vehicles | 3,578 | 3,956 | 5,872 |
| Welding equipment | 858 | 1,103 | 1,679 |
| Industrial ovens | 1,311 | 1,312 | 1,462 |
| Industrial and household cookers | 642 | 722 | 1,261 |
| Flat irons | 354 | 510 | 763 |
| X-ray apparatus, tubes and appliances | 2,710 | 3,372 | 3,439 |
| Telephone equipment | 2,760 | 3,571 | 5,153 |
| Telegraph equipment | 914 | 1,312 | 1,452 |
| Radio transmitters and receivers | 6,634 | 9,683 | 15,136 |
| Signalling and safety devices | 400 | 446 | 543 |
| Switchgear | 5,780 | 6,321 | 7,523 |
| Installation material up to 750 V | 2,417 | 3,143 | 4,351 |
| Cables | 6,125 | 5,875 | 7,732 |
| Insulated wires | 3,151 | 3,632 | 7,465 |
| Insulators | 917 | 668 | 673 |
| Tungsten lamps | 681 | 867 | 1,231 |
| Fluorescent lamps | 88 | 106 | 143 |
| Steam engines and turbines, without boilers | 1,322 | 1,382 | 1,923 |
| Water wheels and turbines | 2,253 | 2,752 | 2,814 |
| Gas engines and turbines | 351 | 312 | 196 |
| Air conditioning equipment | 203 | 401 | 682 |
| Refrigerating equipment, with or without electrical parts | 2,153 | 2,732 | 4,432 |

**TABLE III.—DISTRIBUTION (PERCENTAGE) OF UNITED KINGDOM AND WESTERN GERMAN ELECTRICAL EXPORTS**

| Territory | 1952 | | 1953 | | 1954 | |
|---|---|---|---|---|---|---|
| | W.G. | U.K. | W.G. | U.K. | W.G. | U.K. |
| Europe | 70·6 | 25·8 | 66·0 | 25·6 | 63·5 | 27·8 |
| Americas | 14·3 | 13·2 | 18·5 | 12·2 | 19·4 | 12·1 |
| Asia | 9·6 | 22·7 | 9·9 | 25·6 | 12·3 | 23·2 |
| Africa | 4·9 | 20·3 | 5·1 | 21·0 | 4·7 | 20·4 |
| Australia | 0·6 | 18·0 | 0·5 | 15·6 | 0·1 | 16·5 |

### Vigorous Sales Policy

The outstanding success of the Western German electrical industry is based upon the employment of the latest machinery and materials, resulting in higher productivity; up-to-date designs and willingness to re-design products in order to comply with customers' specifications; frequent visits abroad of principals followed up by vigorous sales drives; agents abroad (mainly professional engineers) who are fully acquainted with their firm's sales policy and supported by attractive sales literature, samples, etc.; technical and commercial flexibility; lavishly equipped stands at fairs; and an unsaturated home market able to absorb any production surplus.

There can be no doubt that, in future, no efforts or money will be spared by the Western German electrical industry to compete even more strongly and successfully with foreign rivals. It is possible that during the later part of this year monthly exports of the Western German electrical industry will overtake those of the United Kingdom. This should be a spur to British manufacturers to exert continued efforts to meet this competition.

## Air-Break Switches

IN revising the 1939 edition of B.S. 861 "Air-break Switches" it has been found desirable to divide the standard into two parts. Part 1 is now available and covers air-break switches and isolators for use on a.c. and d.c. systems with current ratings not exceeding 200 A at voltages of not more than 660 and 500, respectively. Part 2 is at the moment under consideration.

The new edition, which takes into account present-day manufacturing techniques, lays down requirements for marking and construction and states the service conditions envisaged. Tests of making-capacity, breaking-capacity and temperature-rise are prescribed and temperature measurement is dealt with in an appendix.

Copies of the standard may be obtained from the British Standards Institution, Sales Branch, 2, Park Street, London, W.1, price 4s.

# GENERATION AND DEVELOPMENT

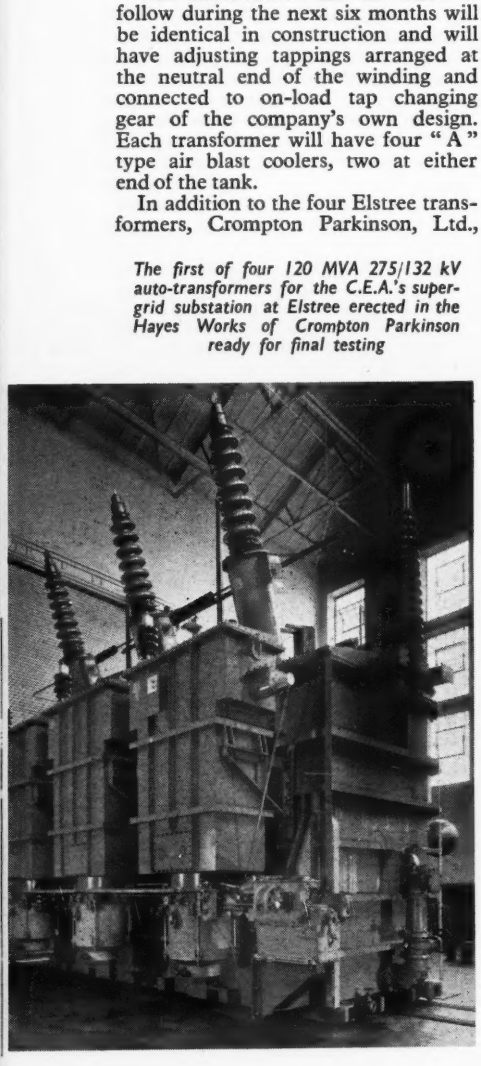
## *Supergrid Transformer for Elstree*

The first of four 120 MVA 275/132 kV, three-phase auto-transformers was recently dispatched from the B.E.T. works of Crompton Parkinson, Ltd., at Hayes, Middx, for the Central Electricity Authority's supergrid substation at Elstree. Weighing upwards of 250 tons when complete, this transformer is one of the largest made in the United Kingdom. A 24-wheel trailer with a 155 h.p. tractor at both the front and the rear was used to transport the equipment to site.

The transformer and the three to follow during the next six months will be identical in construction and will have adjusting tappings arranged at the neutral end of the winding and connected to on-load tap changing gear of the company's own design. Each transformer will have four "A" type air blast coolers, two at either end of the tank.

In addition to the four Elstree transformers, Crompton Parkinson, Ltd., have orders from the C.E.A. for two further units for the new supergrid substation at Iver, Bucks. These will be of the same capacity as those for Elstree, but will be double-wound for 66/275 kV service.

*The first of four 120 MVA 275/132 kV auto-transformers for the C.E.A.'s supergrid substation at Elstree erected in the Hayes Works of Crompton Parkinson ready for final testing*



## *Steam Supply to British Celanese*

An agreement has been completed between the Central Electricity Authority and British Celanese, Ltd., under which a substantial part of the steam used in the British Celanese works at Spondon, near Derby, will be supplied from the Authority's nearby Spondon power station.

There have been many suggestions during the past few years that the Authority should make greater use of the possibilities for economy which arise from the simultaneous supply of steam and electric power from a power station. Investigations of most of the schemes put forward showed, however, that for various reasons they were not economic. In this case the circumstances of the supply are highly favourable. The works of British Celanese, Ltd., and the power station are on adjoining sites, thus requiring only a short delivery system, and the provision of this new supply will enable British Celanese to dispense with some less efficient low pressure boiler capacity.

The agreement, which is the outcome of detailed investigations, provides for by far the largest public supply of steam to industry in the country. Although the steam will be used by British Celanese at the relatively low pressure of 160 lb/sq in, it will be generated at over 900 lb/sq in and then reduced through special back pressure turbines, so producing electricity at very high thermal efficiency. The overall saving in coal in the combined production of steam and electricity in this case is estimated to be 100,000 tons per annum, which in itself is an important justification for the project from a national point of view.

## *Higher Charges in North East*

The North Eastern Electricity Board has announced details of higher electricity charges consequent upon the increase in coal prices. The domestic two-part tariff has been cancelled and all consumers on this rate will be transferred to the domestic block tariff. The primary rate for this tariff, as well as of the farm tariff, has been increased from 4d to 4½d and the final rate of ⅞d has been raised to 1d. The rebate on the prepayment meter tariff has been reduced from 17½ to 12½ per cent and on the load-rate prepayment meter from 12½ to 7½ per cent. The commercial tariff has been increased by ½d/kWh, but there is no change in the industrial tariff which is subject to a fuel price adjustment clause. Mr. T. M. Ayres, chairman of the Electricity Board, stated that the increase in the price of coal would cost the Board £1,400,000 annually. The increases for domestic and commercial consumers represented about 2s 2d in the £.

## *Shropshire Rural Plan*

The whole of the area between Oswestry, Ellesmere, Wem, Cockshutt, the north of Shrewsbury and Kinnerley will have an electricity supply within the next five years. The total cost is expected to be in the region of £250,000. According to present plans work on the project—the area being the fifth under the Merseyside and North Wales Electricity Board's rural development programme—is expected to start in 1958.

Mr. D. H. Kendon, chairman of the Board, addressing the Consultative Council at Chester last week, said that the rural development programme, started in 1949, was a planned method of providing electricity. This was being done county by county, and the Board's drive to provide supplies was now covering fifty miles a month. Sections each of about 20 square miles in area were being completed at one time. The effect of the system could be seen in the number of farms connected each year, namely, 463, 475, 451, 981, 1,049, 1,426, and 1,739 during each of the past seven years, respectively.

## *New Ontario Station*

The Sir Adam Beck generating station No. 2 of the Hydro-Electric Power Commission of Ontario is in full production more than a year ahead of schedule. The twelfth generating unit has been placed in service, giving the $350 million plant on the Niagara Gorge an operating capacity of about 1,200,000 h.p., or slightly more than the Hydro Commission will realize from the St. Lawrence development. Although provision has been made in excavation of the power canal and in design of the power house for four additional units, no decision has been made on the date of installation. The four extra units were planned after the original construction schedule had been set.

Work on the pumped storage scheme is progressing rapidly. The scheme, which will add another 225,000 h.p. to capacity, may be ready late next year and certainly in the spring of 1957.

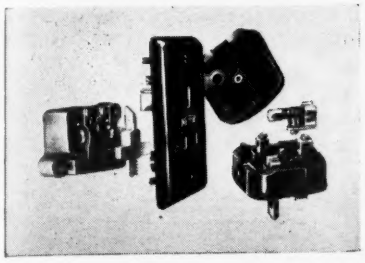
## *Ringsend (Dublin) Station*

The first of the Irish Electricity Supply Board's three new 30 MW generating sets at Ringsend (Dublin) has been on a week's test run on the national network before going into commercial operation. The second set will start operating next December and the third is scheduled to begin some time next summer. When all three are working Ringsend station will be capable of producing 300 million kWh a year, a 20 per cent addition to present E.S.B. output. The station's four 200,000 lb/hr boilers can burn either coal or oil and are fully automatic.

# NEW ELECTRICAL EQUIPMENT

## Plugs and Sockets

A completely new and redesigned flush 13 A socket and plug have just been introduced by NETTLE ACCESSORIES, LTD., Harper Road, Wythenshawe, Manchester. All three wiring terminals are accessible from the top and a reduced size of porcelain base allows more wiring space in the back of the box. The live connection



*Nettle Accessories 13 A plug and socket*

of the fuse end of the plug is now a pillar type terminal.

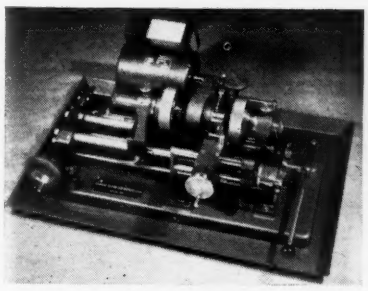
They are available in either a brown, cream or ivory finish and the respective prices for the complete socket and plug are 84s, 94s and 94s per dozen. Prices of the socket only are 47s, 53s and 53s, and of the plug only 39s, 43s and 43s per dozen.

At the same time the company announces that it is now manufacturing its 5 A and 15 A three-pin and also the 13 A three-pin plug tops in hard black moulded rubber. The respective prices per dozen are: 5 A, 45s; 15 A, 63s; and 13 A fused, 52s.

## Commutator Lathe

The "Com-centric" lathe is a new universal machine for turning and undercutting commutators made by BROWNING'S ELECTRIC CO., LTD., Upton Park, London, E.13. The armature is held, on its bearing journals, in two self centering three jaw steadies, thus ensuring that the commutator is turned true with its bearings. The drive is by means of an endless flat belt passing round the armature core. The tungsten

*Browning "Com-centric" lathe*



carbide cutting tool is adjusted by a graduated handwheel giving steps of 0·001in.

The machine will accommodate armatures up to 6in diameter and commutators up to 4in diameter. The steadies will accept bearing journals up to 1in diameter and 9in between journals. Any length of shaft extension, provided the diameter is under 1in, can be passed through the steadies. The motor can be supplied for all normal supply voltages and frequencies either three phase or single phase.

## Miniature Circuit-breakers

A range of three "V & H" single-pole miniature circuit-breakers, suitable for up to 250 V d.c. and 415 V a.c., are now being distributed in this country by DRAKE & GORHAM WHOLESALE, LTD., 77, Long Acre, London, W.C.2. The smallest is the "DSL Dwarf," which can replace the Z-type fuses in existing distribution boards. It has a circular body and push-button action and its screw plug has a standard E27 Edison thread. The "KSL Midget" measures only 1⅛in in width and can be supplied with a neutral link without increasing this width. Connection and fixing are carried out from the front without removal of the cover.

For heavier duty there is the "ISL Industrial" model of robust construction and with a high making and breaking capacity achieved by means of double break and de-ionization chambers. Back-up fuses are not required. For front connection to busbars extension pieces can be supplied. A marine model is available for ship installations.

## Automatic Frying-pan

The latest domestic appliance to be introduced to this country by SUNBEAM ELECTRIC, LTD., 14-16, Old Quebec Street, London, W.1, is a thermostatically controlled automatic frying-pan.

The various cooking temperatures needed are recorded on the handle of the pan and set by a pointer dial. The Sunbeam "Fry-Guide," also on the handle, shows the proper temperatures for the correct preparation of thirteen dishes, including fish, bacon, scrambled eggs and pancakes. Cleaning is simple as the frying-pan can be safely immersed in hot water right up to the temperature dial. The pan can also be used for grilling, stewing, poaching, pot roasting and baking as well as frying. It is deep and can be supplied with a high domed lid, made either of metal or heat resistant glass, and can be used to cook large quantities of food (it is 10½in square). Being mounted on Bakelite feet, it

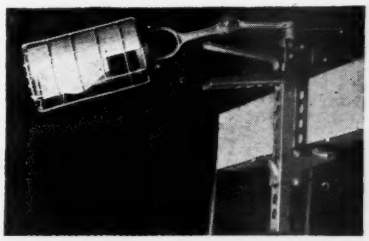
*Sunbeam automatic frying-pan*

can be placed on a sideboard or table without risk of damage to the furniture.

The loading is 1,150 W and the pan is suitable for use on 100-120 V, 200-220 V or 230-250 V a.c. supplies. The price is £7 17s 6d and the lids are £1 2s 6d (aluminium) or £1 1s (glass) extra.

## Inspection Lamp

An inspection lamp with many applications has just been placed on the market by HAROLD JACKSON, 129, St. Mary's Road, Sheffield, 2. The lamp has universal movement on the two patent joints and can also be used as a hand vice. It can be attached to any contour or shape and the grease and oil proof rubber jaws prevent damage to the fixing surface. The cage revolves and is instantly adjustable to any position to ensure maximum illumination. The lamp-holder is easily wired without



*Jackson universal inspection lamp*

dis-assembling and is insulated from the frame with provision for earth connection.

A lamp up to 100 W can be used on 25 to 250 V. To operate it is only necessary to grasp the two handles in one hand and maintain pressure whilst placing the jaws loosely into position on the object by moving the bottom jaw up the ratchet. On releasing the handles the grip is automatically achieved. All steel parts are cadmium plated to prevent rust and the weight is 3¾ lb.

## Blankets and Pads

In the domestic equipment survey dealing with electric blankets and pads (12th August issue) the price of the "Vigilux" models TV1 and TV2 blankets, products of the Warmglow Co., Ltd., should have read £16 1s 3d and not £18 1s 3d (excluding purchase tax).

## *Financial Section*

# STOCKS and SHARES

MARKETS of the Stock Exchange reckon as a rule to be left in peace from the intrusion of political action during Parliament's summer recess. At this particular season, matters are so much otherwise as to leave the movement of prices and the conduct of investment very much at the mercy of Government decisions, either actual or apprehended, to deal with the deterioration in financial and economic affairs. For the time being, markets wear, consequently, a very ragged appearance. Few commentators profess to be able to see their way ahead from one day to another, although most are agreed that the holder of good securities is best advised to ride out the disturbance.

### The Punctured Boom

By the beginning of this month, all that was left of the industrial share boom which has had so much political and other sorts of publicity this year, was an average appreciation of not much over 5 per cent since January. The index to share prices was showing a drop of some 14 per cent over the short space of time since mid-July. The experience of individual shares can be judged from a comparison, in the accompanying tables, of recent prices with the "high-low" figures for the year, in the last column. As a generalization, it might be said that in the case of electrical engineering and equipment shares, prices stand now roughly midway between the year's best and worst. This represents a state of affairs a good deal firmer than that existing in many less well-favoured sections of the industrial market.

### Hackbridge Cable

Good annual results from Hackbridge Cable Holdings made the shares a notably firm exception to surrounding weakness. They hardened to 20s 9d on the strength of a final dividend making a total of 25 per cent for the year to last March. Previously, a regular 20 per cent had been paid since the registration of the present company in 1948. All the units of the group, including the newly-acquired Bryce and Siemens-Schuckert subsidiaries, are said in the report to have contributed to an expansion in the net group profit from £211,000 to £308,000, which covers very comfortably the dividend distribution. In the balance-sheet, reserves are shown now to exceed the £450,000 ordinary capital, which is supported by an equal amount of 5 per cent preference stock. Sir Wavell Wakefield, the chairman, reports that trading has continued to be satisfactory in the current year.

### James Scott

After being a good deal higher, the 5s ordinary shares of James Scott (Electrical Engineers) have been quoted lately at about 1s above the price of 11s 6d at which they were placed in the market a month ago. Financial year of the company ends next January. In the particulars published in connection

## *The Week's Price Changes*

| Company or Board | Nom. Value | Middle price 5th Sept. | Week's Rise or Fall | Dividend Previous | Dividend Last | Yield % | 1955 Highest | 1955 Lowest |
|---|---|---|---|---|---|---|---|---|
| *Gilt-edged Stocks* | | | | | | £ s d | | |
| Brit. Elec. 1968/73 ... ... | 100 | 76½ | −2 | 3 | 3 | 3 18 6 | 94⅞ | 76½ |
| Brit. Elec. 1974/77 ... ... | 100 | 75½ | −1 | 3 | 3 | 3 19 6 | 93⅞ | 75½ |
| Brit. Elec. 1976/79 ... ... | 100 | 81½ | −2 | 3½ | 3½ | 4 6 0 | 98⅞ | 81½ |
| Brit. Elec. 1974/79 ... ... | 100 | 90½ | −2 | 4¼ | 4¼ | 4 14 0 | 109 | 90½ |
| *Overseas Electric Supply* | | | | | | | | |
| Calcutta Elec. ... ... ... | £1 | 22/6 | +6d | 6† | 6† | 5 6 9 | 22/6 | 20/9 |
| East African Power ... ... | £1 | 22/6 | | 7 | 7 | 6 4 6 | 24/6 | 19/9 |
| Nigerian Elec. ... ... ... | £1 | 22/6 | −1/- | 10 | 10 | 8 17 9 | 27/- | 22/6 |
| Palestine Elec. "A" ... ... | £1 | 21/- | | Nil | Nil | — | 22/9 | 21/- |
| Perak Hydro-Elec. ... ... | £1 | 20/- | | 6 | 10 | 10 0 0 | 21/6 | 17/9 |
| *Equipment and Manufacturing* | | | | | | | | |
| Aberdare Cables ... ... ... | 5/- | 12/- | | 12½ | 17½ | — | 14/6 | 11/- |
| Aerialite ... ... ... | 1/- | 6/3 | | 88⅛ | 88⅛ | — | 6/7 | 5/3 |
| Allen, W. H. ... ... ... | £1 | 77/6 | | 20 | 20 | 5 3 3 | 83/9 | 77/- |
| Aron Elec. Ord. ... ... ... | £1 | 57/6 | | 15 | 15 | 5 4 3 | 63/9 | 55/6 |
| Assoc. Elec. Ord. ... ... | £1 | 86/3 | −3/9 | 11¼ | 14 | 3 5 0 | 96/- | 65/3 |
| Automatic Tel. & El. ... ... | £1 | 67/6 | −2/6 | 15 | 15* | 4 9 0 | 79/6 | 67/6 |
| Babcock & Wilcox ... ... | £1 | 83/9 | −1/3 | 12* | 15 | 3 11 9 | 98/- | 68/6 |
| Baldwin, H. J. ... ... ... | 2/- | 4/9 | −3d | 20 | 20 | 8 8 6 | 5/6 | 4/4 |
| Bakelite ... ... ... ... | 10/- | 32/6 | −6d | 12½ | 16 | 4 18 6 | 34/6 | 27/- |
| British Aluminium ... ... | £1 | 50/- | | 10 | 12 | 4 16 0 | 58/- | 35/3 |
| B.I. Callender's ... ... ... | £1 | 46/- | −1/6 | 10 | 10 | 4 7 0 | 55/3 | 44/9 |
| B.I. Callender's 6% Pref. ... | £1 | 22/- | −1/- | 6 | 6 | 5 9 0 | 26/6 | 22/- |
| British Thermostat ... ... | 5/- | 31/3 | −1/3 | 27½ | 27½ | 4 8 0 | 35/- | 22/6 |
| British Vac. Cleaner ... ... | 5/- | 7/6 | | 25 | 30 | — | 10/- | 7/- |
| Brook Motors ... ... ... | 10/- | 46/3 | | 20 | 20* | 4 6 6 | 46/3 | 39/9 |
| Brush Ord. ... ... ... | 5/- | 8/6 | −9d | 6 | 10 | 5 17 9 | 9/6 | 7/7 |
| Bulgin, A. F. ... ... ... | 1/- | 7/- | −6d | 30 | 45 | 6 8 6 | 8/- | 4/- |
| Burco Dean ... ... ... | 5/- | 13/3 | −6d | — | — | — | 17/3 | 13/3 |
| Chloride El. Storage ... ... | £1 | 66/3 | −2/6 | 12½ | 17½ | 5 8 1 | 77/6 | 58/6 |
| Clarke Chapman ... ... ... | £1 | 100/- | −2/6 | 20 | 20* | 4 0 0 | 102/6 | 68/9 |
| Cole, E. K.... ... ... | 5/- | 22/- | −1/- | 27½ | 17½* | 3 19 6 | 25/6 | 18/3 |
| Cossor, A. C. ... ... ... | 5/- | 11/- | −1/- | 10 | 15 | 6 16 4 | 14/- | 8/9 |
| Crabtree ... ... ... ... | 10/- | 30/9 | | 17½ | 20 | 6 10 0 | 34/6 | 29/3 |
| Crompton Parkinson Ord. ... | 5/- | 16/6 | | 20 | 20 | — | 19/9 | 16/- |
| De La Rue ... ... ... | 5/- | 20/- | −1/3 | 20 | 30 | 7 10 0 | 26/- | 18/9 |
| Decca ... ... ... ... | 4/- | 38/9 | −1/3 | 35 | 56¼* | — | 48/9 | 31 - |
| Desoutter ... ... ... ... | 5/- | 33/9 | | 20 | 25 | 3 14 0 | 35/- | 25/6 |
| Dewhurst ... ... ... ... | 2/- | 10/- | | 19 | 24 | 4 16 0 | 10/6 | 7/3 |
| Dictograph Tel. ... ... ... | 2/- | 8/- | −1/3 | 20 | 20 | 5 0 0 | 9/3 | 6/6 |
| Dubilier Condenser ... ... | 1/- | 4/3 | | 25 | 25* | 5 17 9 | 5/7 | 3/10 |
| E.M.I. ... ... ... ... | 10/- | 26/9 | −9d | 8 | 10 | 3 14 9 | 37/- | 25/3 |
| Electrical Components ... ... | 5/- | 18/9 | | 20 | 25 | 6 13 4 | 21/3 | 15/3 |
| Elec. Construction ... ... | £1 | 32/6 | −2/6 | 15 | 8¼* | 5 4 6 | 41/3 | 31/6 |
| Enfield Cable Ord. ... ... | £1 | 21/3 | | Nil | Nil | Nil | 25/3 | 20,- |
| English Electric ... ... ... | £1 | 77/6 | −2/6 | 10 | 12½ | 3 4 6 | 86/9 | 54/3 |
| English Electric 3½% Pref. ... | £1 | 14/- | | 3½ | 3½ | 5 7 3 | 16/9 | 14/- |
| Ericsson Tel ... ... ... | 5/- | 40/6 | −1/- | 25† | 20†* | 2 9 6† | 46/6 | 29/- |
| Ever Ready ... ... ... | 5/- | 31/9 | −9d | 40 | 35* | 5 10 3 | 38/- | 22/3 |
| Falk Stadelmann ... ... ... | £1 | 42/6 | −3/3 | 15 | 15 | 6 15 8 | 52/6 | 43/9 |
| G.E.C. Ord. ... ... ... | £1 | 66/3 | −3/9 | 12½ | 14 | 4 4 10 | 80/3 | 51/3 |
| G.E.C. 6¼% Pref. ... ... ... | £1 | 23/9 | | 6¼ | 6¼ | 5 9 5 | 28/4 | 23/6 |
| General Cables ... ... ... | 5/- | 15/- | | 30 | 30 | 10 0 0 | 17/- | 15/- |
| Greenwood & Batley ... ... | £1 | 57/6 | | 17½ | 17½ | 6 1 9 | 57/6 | 54/6 |
| Hackbridge Cable ... ... | 5/- | 20/9 | +1/- | 20 | 25 | 6 0 6 | 22/6 | 14/- |
| Hackbridge & Hewittic ... ... | 5/- | 20/6 | +9d | 25 | 30 | — | 24/9 | 17/- |
| Hall Tel. Acc. ... ... ... | 10/- | 19/- | +6d | 10 | 10 | 5 5 3 | 22/6 | 11/- |
| Heatrae ... ... ... ... | 2/- | 5/- | | 12½ | 15 | 6 0 0 | 5/9 | 4/3 |
| Henley's ... ... ... ... | 10/- | 17/- | −1/- | 10½ | 10½ | 6 3 6 | 21/3 | 17/- |
| Holophane ... ... ... | 5/- | 17/6 | | 20 | 25 | 7 2 10 | 19/9 | 16/- |

* After scrip issue. † Free of income tax.

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.

with the marketing of the shares, the board anticipated that profits (which have been rising considerably in recent years) should be not less than £140,000, in which event the board would expect to recommend a 17½ per cent dividend on the £254,000 ordinary stock. A distribution at that rate would be covered roughly twice on the basis of the estimated profit, and would produce a yield of 7 per cent on the shares at their present price. The intention is to make an interim distribution of 5 per cent about February.

## *in Electrical Investments*

| Company or Board | Nom. Value | Middle price 5th Sept. | Week's Rise or Fall | Dividend Previous | Dividend Last | Yield % £ s d | 1955 Highest | 1955 Lowest |
|---|---|---|---|---|---|---|---|---|
| *Equipment and Manufacturing—continued* | | | | | | | | |
| Hoover | 5/- | 43/6 | −1/- | 45 | 70 | 8 1 0 | 52/6 | 40/- |
| I.C.I. | £1 | 50/9 | −9d | 15 | 10* | 3 18 10 | 61/9 | 38/3 |
| Intl. Combustion | 5/- | 19/- | −1/- | 20 | 25 | — | 24/6 | 16/3 |
| Johnson & Phillips | £1 | 43/3 | | 15 | 15 | 6 18 9 | 52/6 | 41/- |
| Lancashire Dynamo | £1 | 52/6 | −2/6 | 14 | 15 | — | 56/3 | 37/3 |
| Laurence, Scott | 5/- | 18/- | | 20 | 12½* | 3 9 0 | 19/6 | 14/6 |
| Lister, R. A. | £1 | 32/6 | | 12 | 9·3* | 5 14 6 | 40/- | 30/6 |
| London Elec. Wire | £1 | 51/3 | | 10 | 12½ | 4 17 6 | 61/3 | 50/6 |
| Lucas, J. | £1 | 46/3 | −1/- | 10·8 | 7½* | 3 4 9 | 56/6 | 41/6 |
| Marryat & Scott | 2/- | 12/3 | | 25 | 30 | 4 18 0 | 13/- | 9/6 |
| Mather & Platt | £1 | 65/6 | −4/- | 15 | 13·4* | — | 75/- | 48/- |
| Metal Industries | £1 | 26/6 | −3d | 9 | 9 | 6 15 9 | 38/- | 26/6 |
| Midland Elec. Mfg. | £1 | 50/- | | 15 | 10* | 4 0 0 | 55/- | 44/- |
| Morphy-Richards | 4/- | 27/6 | | 40 | 35* | 5 1 9 | 35/- | 27/- |
| Murex | £1 | 57/6 | −2/6 | 15 | 15 | 5 4 3 | 66/- | 49/3 |
| Newman Ind. | 2/- | 2/9 | | 10 | 10 | 7 5 6 | 3/6 | 2/4 |
| Oldham & Son | 1/- | 3/-x.c. | | 17½ | 20 | 6 13 4 | 3/6 | 2/1 |
| Parnall (Yate) | 5/- | 8/9 | −6d | 8 | 14 | 8 0 0 | 13/2 | 7/3 |
| Parsons, C. A. | £1 | 86/3 | −2/6 | 7½ | 10 | 2 6 6 | 100/- | 56/- |
| Plessey | 10/- | 70/9 | −3/- | 30 | 20* | 2 16 6 | 89/- | 57/6 |
| Pye Deferred | 5/- | 40/- | | 20 | 12½* | 3 2 6 | 47/6 | 28/6 |
| Revo | 10/- | 13/9 | | 27½ | 9* | 6 11 0 | 15/6 | 12/6 |
| Reyrolle | £1 | 110/- | | 13½ | 15 | 2 14 6 | 127/6 | 89/- |
| Rheostatic | 4/- | 13/3 | | 20 | 22½ | — | 14/3 | 9/3 |
| Richardsons Westgarth | 5/- | 16/3 | | 15 | 15* | 4 12 3 | 19/- | 11/- |
| Scottish Cables | 4/- | 18/9 | | 27½ | 27½ | 5 17 3 | 22/6 | 18/9 |
| Smith (England), S. | 4/- | 16/- | −1/6 | 15 | 17½ | 4 7 6 | 20/- | 15/- |
| Southern Areas | £1 | 32/6 | | 7½ | 10 | 6 3 0 | 38/- | 27/6 |
| Strand Elec. | 5/- | 12/- | −1/3 | 17½ | 15* | 6 5 0 | 13/3 | 8/6 |
| Sturtevant | 5/- | 30/- | −1/3 | 18·9 | 14·4†* | 2 8 0† | 35/9 | 21/- |
| Sun. Elec. | £1 | 35/- | | 15 | 15 | 8 11 6 | 35/- | 33/9 |
| Switchgear & Cowans | 5/- | 13/9 | | 10 | 20 | 7 5 6 | 17/- | 11/- |
| Taylot Tunnicliff | 5/- | 13/9 | | 12½ | 15 | 5 9 0 | 16/3 | 11/3 |
| T.C.C. | 10/- | 52/6 | | 30 | 25* | 4 15 3 | 53/9 | 41/- |
| T.C. & M. | £1 | 32/- | −1/- | 8½ | 8½ | 5 6 3 | 40/9 | 32/- |
| Telephone Mfg. | 5/- | 10/9 | | 10 | 10 | 4 13 0 | 11/6 | 9/3 |
| Thorn Elec. | 5/- | 22/6 | −1/3 | 20 | 15* | 3 6 8 | 33/- | 13/9 |
| Thornycroft | £1 | 42/6 | −2/6 | 15 | 15 | — | 47/6 | 34/6 |
| Tube Investments | £1 | 95/- | | 15 | 17½ | 3 13 9 | 107/6 | 72/6 |
| Vactric | 5/- | 17/6 | | 10 | 15* | 4 5 9 | 22/- | 12/- |
| Veritys | 5/- | 11/- | | 12½ | 12½ | 5 13 3 | 11/- | 7/- |
| Walsall Conduits | 4/- | 14/6 | | 70 | 70 | — | 17/3 | 12/- |
| Ward & Goldstone | 5/- | 34/6 | −6d | 50 | 30* | 4 7 0 | 45/- | 34/6 |
| Watford | 2/- | 8/- | | 22½ | 25 | — | 8/9 | 6/3 |
| Westinghouse Brake | £1 | 96/6 | −2/3 | 16 | 18 | 3 14 9 | 110/- | 82/- |
| West, Allen | 5/- | 13/6 | −6d | 17½ | 15* | 5 11 0 | 16/6 | 8/- |
| Wolf Electric | 5/- | 20/- | | 17½ | 20 | 5 0 0 | 21/- | 16/1 |
| *Trusts, Transport and Communications* | | | | | | | | |
| Anglo-Am Tel.: | | | | | | | | |
| A. Ord. | 100 | 67½ | | 6 | 6 | 8 17 6 | 88 | 67½ |
| Ord. | 100 | 45 | | 3¾ | 3¾ | 8 6 8 | 54½ | 45 |
| Anglo-Portuguese | £1 | 23/- | | 8 | 8 | 6 19 3 | 27/- | 21/- |
| Brit. Elec. Traction: | | | | | | | | |
| Def. Ord. | 5/- | 20/- | −1/- | 50 | 22½* | 5 12 6 | 24/3 | 19/6 |
| Cable & Wireless: | | | | | | | | |
| Ord. | £1 | 47/- | −6d | 9 | 10 | 4 5 0 | 54/- | 39/6 |
| 4% Loan | 100 | 92½ | | 4 | 4 | 4 6 6 | 100/- | 92 |
| Calcutta Trams | £1 | 26/- | | 6† | 7½†† | 5 15 6† | 26/- | 20/- |
| Cape Elec. Trams | £1 | 19/6 | +6d | 5½ | 7½ | 7 14 0 | 19/6 | 16/6 |
| Marconi Marine | £1 | 36/3 | | 10 | 10 | 5 10 3 | 41/3 | 33/- |
| Oriental Tel. Ord. | 1/- | 73/9 | +1/3 | 16 | — | — | 102/6 | 72/6 |
| Telephone Rentals | 5/- | 11/9 | | 10 | 12½ | 5 6 6 | 13/6 | 9/6 |

### A. C. Cossor Results

Items of individual company news have difficulty in making much impression on shares influenced at present by more general forces, so that it is difficult to interpret the fall in A. C. Cossor 5s shares to 11s, following the declaration of the final dividend and profits statement for the year ended last March. With increases in turnover during the year from £7·3 to £9·2 million, and in the net trading surplus from £527,000 to £653,000, the single distribution on the ordinary shares is to be 15 per cent, against the 10 per cent paid on the three previous occasions. The amount is covered twice by the earnings available, and the yield from the shares on the basis of the new rate works out at rather more than 6¾ per cent. The reaction of the shares to the good annual results was perhaps modified by the cautious tenor of the chairman's review. After reporting that in the current year sales have exceeded those during the parallel period a year ago, he refers to the planning difficulties created by changes one way and another in the h.p. regulations and by other Government economic action.

### Kenya Power Issue

Subscription lists are due to open next Tuesday, 13th September, in London and Nairobi, for an issue of £7½ million Kenya Power Company 5½ per cent debenture stock, redeemable 1975/85, at a price of 101. It is to be a public issue, with preferential consideration to shareholders of East African Power & Lighting, which owns the share capital of the Kenya Company jointly with the local Government and Power Securities Corporation. This offer of a high-grade debenture on a yield basis of almost 5½ per cent illustrates in a practical way the extent to which the Government's money policy has raised the rates for industrial borrowing.

### Oriental Telephone

In his statement circulated with the annual accounts, the chairman of the Oriental Telephone & Electric Co. was unable to indicate any definite date by which the conditions necessary for voluntary liquidation might be fulfilled. One of these is agreement on the price to be paid for the Singapore and Johore Bahru undertakings; the other is the disposal of the China and Japan Telephone subsidiary. So far as the ultimate "break-up" value of the shares is concerned, the final tax liabilities of the company figure as an important item in market calculations. Earlier estimates underwent a good deal of revision on the chairman's references to the position in that respect. The result was a drop of 10s to 72s 6d in the price of the shares (which are now of 1s denomination) and a mild recovery to 73s 9d.

# REPORTS and DIVIDENDS

**Thorn Electrical Industries, Ltd.**—At the annual meeting on 2nd September Mr. Jules Thorn (chairman and managing director) said that in the face of increasing competition the Atlas Lighting Division had continued to expand. The year had seen considerable changes in the trading structure of the industry, brought about to some extent by the competitive prices at which they had been able to sell their products. Referring to their main lamp factory at Merthyr Tydfil, he said that the original factory had been re-equipped with the most up-to-date machinery of their own design and manufacture and a duplicate factory of the same size, now being erected, would begin production towards the end of this year. When completed it would probably be the largest unit in Europe producing lamps of this type. On the commercial side, they had been successful in obtaining large contracts from the Government and every class of user. This year they would be considerably extending their activities in the street lighting field.

In radio and television, the position of their Ferguson Division had been further consolidated. Production of their television receivers had been running at a very high level and in May last they made their 500,000th set. As already announced, arrangements had been completed with Sylvania Electric Products, Inc., to form a joint company for the manufacture of cathode-ray tubes; this ambitious project would naturally take some time to take shape. It was too early for him to say much about Sylvania-Thorn Colour Television Laboratories, Ltd., which was formed last year by Sylvania and themselves.

The Export Division had shown the largest turnover on record and in the field of fluorescent tubes the company had been responsible for more than 70 per cent of the total exports from this country. The company had brought into this country from the United States alone more than $1·8 million during the year under review.

**Parmiter, Hope & Sugden, Ltd.**—Mr. E. W. Sugden, chairman, said at the annual meeting last week that the opinion he had expressed at last year's meeting that the recession had passed had been rather premature, although he was glad to be able to add that it had been later justified by a greatly improved ordering rate since the beginning of 1955. This delay in returning to better conditions, coupled with the company's reluctance to advance the prices of its products to meet increased costs, had resulted in a marked fall in the trading profit, but the difficulties had been met without actual loss. Despite advances averaging about 13½ per cent in the company's prices, the market had improved to a rate of ordering which exceeded that for any comparable period during the last three years.

As this improvement in trading had now lasted for over half a year he felt confident that they had now entered a period of substantially improved trading, though he expressed concern at the increasing shortages of key materials of every type, as well as of workers and staff for both manual and technical requirements.

During the year attention had continued to be paid to new developments. A new design of high breaking capacity cartridge fuse-links, suitable for special markets overseas, had been developed and tested with great success, and these appeared to encourage hopes that a new and fertile field for commercial activity might become available in the near future. With a view to introducing the company's products into a wider field of application, a novel and attractive style of pressed steel distribution box enclosure had been developed and produced.

**Hackbridge Cable Holdings, Ltd.**—The accounts for the year ended 31st March last show consolidated trading profits, after depreciation, of £582,048 (against £444,774 for 1953-54). Taxation absorbs £273,646 (£233,278) and the combined net profit is £308,402 (£211,496). From this is deducted £199,290, proportion of profit attributable to a newly acquired subsidiary accrued from 1st April, 1954, to date of acquisition by the holding company, which is transferred to capital reserve. The net balance is thus reduced to £109,112. The dividend for the year is raised from the 20 per cent paid since the company's incorporation to 25 per cent by a final distribution of 17½ per cent (against 12½ per cent). A sum of £33,013 (£149,838) is retained by subsidiaries and £2,639 (£2,899) is carried forward.

In his statement issued with the report and accounts the chairman (Sir Wavell Wakefield) says that all units have participated in the improvement over the previous year, including the newly acquired subsidiaries. Although the Bryce and Siemens-Schuckert unit was acquired on the basis of a consolidated balance sheet prepared as at 31st March, 1954, a considerable time elapsed before the formalities were completed and only a small proportion of the profits earned by this unit is available for dividend purposes in respect of the year under review. With regard to the outlook, he says that trading since the end of the financial year has continued to be satisfactory. Last year reference was made to the continuing increase in demand, both at home and abroad, for the company's principal manufactures, comprising electric cables, power transformers and capacitors. Arising out of the acquisition of the Bryce-Siemens unit there is now added a wide range of mechanical and electrical equipment. Development work towards the further improvement of facilities for sheathing cables with aluminium by the direct extrusion process has continued. Meeting: 23rd September.

**A. C. Cossor, Ltd.,** report group trading profits for the year ended 31st March last of £652,545 (against £527,419). Net profits after depreciation and provision of £239,152 (£213,517) for taxation amount to £254,740 (£169,127). The ordinary dividend for the year is raised from 10 to 15 per cent and the group balance carried forward is £278,408 (£179,612). Turnover of the group rose last year from £7,300,000 to £9,200,000, including £1,600,000 of exports.

The chairman (Lord Burghley) says that reimposition of hire-purchase restrictions and seasonal trade slackness led to a quiet opening for the current year, but sales to date have exceeded those in the corresponding period of last year. It is hoped that the start of commercial television and the B.B.C.'s increased television programme time will stimulate the demand for television sets. The further tightening of hire-purchase regulations has, however, made accurate planning of production and sales exceedingly difficult. Meeting: 22nd September.

**London Electrical & General Trust, Ltd.**—The accounts for the year to 30th June show gross income amounting to £132,908, an increase of £27,668 over the total for 1953-54. The chairman, Capt. A. R. S. Nutting, says that this is partly due to the receipt of income on the £240,000 raised by an issue of new ordinary shares last January and also to larger dividends received on many of the company's investments. Of the £49,589 available after meeting all charges and paying the preference dividends £12,500 is transferred to reserve. The interim dividend of 4 per cent on £240,000 ordinary stock together with the proposed final dividend of 9 per cent on £480,000 stock absorb £30,120; the comparable figure last year was £19,800 (4 per cent interim and 15 per cent final).

**Walsall Conduits, Ltd.,** has declared an interim dividend of 7½ per cent on the £800,000 ordinary capital as increased by a three-for-one scrip issue. Last year the interim payment on the old capital was 20 per cent.

**The Chloride Electrical Storage Co., Ltd.,** is paying an unchanged interim dividend of 5 per cent on the "A" and "B" ordinary stock.

**The Rheostatic Co., Ltd.,** has announced an interim dividend of 6 per cent (against 7½ per cent last year on smaller capital).

**The Telegraph Condenser Co., Ltd.,** is maintaining its interim dividend at 5 per cent.

(*Continued on page 519*)

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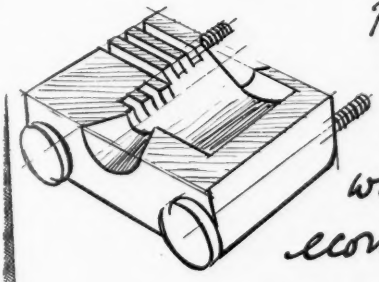
INTER-OFFICE MEMORANDUM

From D. D. O.

To CHIEF ENGINEER (SWITCHGEAR DEPT.)

Subject: PROJECT 586, SUBASSEMBLY 863 JET-POTS



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## FINANCIAL SECTION (*continued*)

### New Companies

**G. W. Gaines (Electrical), Ltd.**—Registered 13th August. Capital £3,000. Manufacturers of and dealers in electrical goods of all kinds, etc. Directors: G. W. Gaines, Mrs. Audrey R. Hewstone and Mrs. Dorothy M. Hewstone. Regd. office: 2, Ladywell Road, Lewisham, S.E.13.

**G. A. Curry & Co., Ltd.**—Registered 20th July. Capital £3,000. Manufacturers of and dealers in electrical and photographic equipment, etc. Directors: G. A. Curry and W. C. Thompson. Regd. office: 169, Midland Road, E.10.

**Neon Manufacturers, Ltd.**—Registered 30th July. Capital £1,000. Manufacturers and distributors of, agents for and wholesale and retail dealers in neon signs, etc. Directors: F. C. Dillnutt (secretary) and Mrs. Mary D. Dillnutt. Regd. office: 13, St. James' Row, London, E.C.1.

**John Walker & Son (Wire), Ltd.**—Registered 30th August. Capital £1,000. Manufacturers and processors of wire, wire drawers, platers and coverers, etc. Permanent directors: A. Walker and Mrs. Mabel Walker. Secretary: D. Smith. Regd. office: Valley Mills, Moorbottom, Cleckheaton.

**D. Frame (Springfield), Ltd.**—Registered 31st August. Capital £200. Electricians, electrical, mechanical, metallurgical and chemical engineers, etc. Directors: D. Frame and Doris Frame (secretary). Regd. office: 25, Roebuck Lane, Sale, Manchester.

**Prices (Leigh), Ltd.**—Registered 31st August. Capital £10,000. Radar, television, electrical and general engineers, etc. Permanent directors are: W. Price (chairman) and Anne Price (secretary). Regd. office: 63, Bradshawgate, Leigh, Lancs.

**Balls & Howes, Ltd.**—Registered 30th August. Capital £500. Electrical engineers, general electrical installation contractors and radio engineers, etc. Directors: F. H. Balls (secretary) and W. S. Howes. Regd. office: 150, London Road, Southborough, Tunbridge Wells, Kent.

### Increases of Capital

**English Electric Valve Co., Ltd.**—Increased by £250,000, in £1 ordinary shares, beyond the registered capital of £250,000. At 6th April, 1955, the English Electric Co., Ltd., held a majority of the issued shares.

**T. W. Broadbent, Ltd.**—Increased by £15,000, in £5 ordinary shares, beyond the registered capital of £5,000.

**Elliotts Liverpool, Ltd.**—Increased by £2,700, in £1 ordinary shares, beyond the registered capital of £300.

**James Scott & Co., Ltd.**—Increased by £270,000, in 138,500 6½ per cent cumulative preference shares of £1 and 526,000 ordinary shares of 5s, beyond the registered capital of £280,000.

**Santon (Wholesale), Ltd.**—Increased by £2,000, in £1 redeemable preference shares, beyond the registered capital of £15,000.

**Engineering & Lighting Equipment Co., Ltd.**—Increased by £50,000, in 2s ordinary shares, beyond the registered capital of £200,000.

**E. Boydell & Co. Ltd.**—Increased by £397,500, in £1 ordinary shares, beyond the registered capital of £2,500.

### Liquidations

**Eckington Electric Supply Co., Ltd.** (in voluntary liquidation).—General meeting of members 5th October at the Council Offices, Church Street, Eckington, Derbyshire, to receive an account of the winding-up by the liquidator, Mr. E. R. Birley.

**Henray Electrical Co., Ltd.**, manufacturers and merchants of vacuum cleaners, etc., 53, Queen Anne Street, London, W.1.—Last day for receiving proofs for dividend 16th September. Liquidator, Mr. D. Morgan, 100, Park Street, Grosvenor Square, London, W.1.

### Bankruptcies

**P. K. Eichenberger,** radio dealer, carrying on business at 30, Market Place, Boston, Lincs.—Supplemental dividend of 11s in the £ (making 20s in all) payable 12th September at the Official Receiver's office, 27, Regent Street, Park Row, Nottingham.

**J. L. Pulford,** 4, New Platt Lane, Goostrey, Holmes Chapel, Cheshire, radio engineer.—Trustee, Mr. F. C. Ormrod, 12, Lonsdale Street, Stoke-on-Trent, Official Receiver, released 24th August.

## CATALOGUES AND LISTS

**CABLE TRUNKING.**—90-page priced catalogue of the company's cable trunking and cable tap system.—**Mantel Metalworkers, Ltd.,** 121, Gurney Street, London, S.E.17.

**DISTRIBUTION SYSTEM.**—Four leaflets dealing with trolley feed rail and distribution duct systems for lighting, portable electric tool and similar applications.—**E.M.S. Electrical Products, Ltd.,** 28-32, The Butts, Coventry.

**ELEVATORS.**—Brochure, specially prepared for users in the American continent, dealing with the company's lifts and elevators.—**Marryat & Scott, Ltd.,** Wellington Works, Hounslow, Middlesex.

**FLUORESCENT FITTINGS.**—Illustrated broadsheet describing a range of fluorescent fittings, control gear and accessories.—**Ensel Electric Co., Ltd.,** 218-219, Upper Street, London, N.1.

**HEATING.**—Illustrated folders describing the "Expamet" industrial space heater and electric air heaters.—**Expanded Metal Co., Ltd.,** Burwood House, Caxton Street, London, S.W.1.

**INSULATION MATERIALS.**—Booklet describing Class H silicone insulation materials produced by the company.—**Midland Silicones, Ltd.,** 19, Upper Brook Street, London, W.1.

**INSULATORS.** — Pamphlet describing tests carried out on "Dimex" rod type insulators.—**Electric Transmission, Ltd.,** Etruria, Stoke-on-Trent, Staffs.

**MOTORS.**—Descriptive brochure showing the application of the company's range of geared motors and speed reducers.—**Electropower Gears, Ltd.,** Kingsbury Works, Kingsbury Road, London, N.W.9.

Illustrated brochure (ML.81), dealing with motors for power stations.—**Lancashire Dynamo & Crypto, Ltd.,** Trafford Park, Manchester, 17.

**RECTIFIERS.**—Folder (NR.550), describing and illustrating "Nevitron" mercury arc rectifier equipment.—**Nevelin Electric Co., Ltd.,** Purley Way, Croydon, Surrey.

26-page booklet illustrating and describing glass bulb rectifying equipment.—**Hackbridge and Hewittic Electric Co., Ltd.,** Walton-on-Thames, Surrey.

**RELAYS.**—72-page brochure giving details of the range of English Electric protective and auxiliary relays.—**English Electric Co., Ltd.,** Stafford.

**TIME SWITCHES.**—Loose-leaf priced catalogue covering the "Gunfire" range of time switches.—**British, Foreign & Colonial Automatic Light Controlling Co., Ltd.,** Bournemouth.

**TRANSFORMERS.** — Three descriptive brochures on the company's "Green Seal" and "Polemaster" transformers, and tail-end boosters.—**Brentford Transformers, Ltd.,** Kidbrooke Park Road, Kidbrooke, London, S.E.3.

**TRUCKS.**—12-page illustrated catalogue on the company's range of hydraulic lifting and stacking trucks.—**J. Collis & Sons, Ltd.,** Regent Square, Gray's Inn Road, London, W.C.1.

**VALVES.**—37-page technical booklet dealing with electrically operated valves for the control of hydraulic power.—**Electro-Hydraulics, Ltd.,** Liverpool Road, Warrington.

**VENTILATION.** — 16-page illustrated booklet (3604), dealing with equipment for exhaust ventilation.—**Sturtevant Engineering Co., Ltd.,** Southern House, Cannon Street, London, E.C.4.

## TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 24th September:—

CHANTECLAIRE. No. 738,292, Class 9. Sound recording and reproducing apparatus and instruments; radio apparatus, loudspeakers and talking machines, etc.—Vox-Schallplatten G.m.b.H., Cologne, Germany. Address for service, c/o Pollak, Mercer & Tench, 134, Cheapside, London, E.C.2.

ARCAIR. No. 741,430, Class 9. Electric welding apparatus, incorporating gas-jet nozzle heads for use in the working of metals; parts of such apparatus; and electrodes.—Arcair Company, Lancaster, Ohio, U.S.A. Address for service, c/o F. J. Cleveland & Co., 29, Southampton Buildings, Chancery Lane, London, W.C.2.

VYON. No. 742,202, Class 9. Electric accumulators and parts.—Pritchett & Gold and E.P.S. Co., Ltd., Dagenham Dock, Essex.

FURMARAY. No. 742,601, Class 9. Electric transmitting apparatus.—B. N. Furman (Productions), Ltd., 133, Fonthill Road, Finsbury Park, London, N.4.

LONORLUX. No. 742,796, Class 9. Electric vacuum cleaners and radio sets.—Lonor, Ltd., 1, New Burlington Street, London, W.1.

MEKOND. No. 739,510, Class 11. Electric lighting installations.—Mek-Elek Engineering, Ltd., 17, Western Road, Mitcham, Surrey.

TWIMERSER. No. 739,534, Class 11. All goods included in this class.—Hotpoint Electric Appliance Co., Ltd., Crown House, Aldwych, London, W.C.2.

YELSEN. No. 742,155, Class 11. Electric radiators.—Yelsen, Ltd., 9, Hatherley Road, Sidcup, Kent.

# NEW PATENTS

## Electrical Specifications Recently Published

*The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 12th October from the Patent Office, 25, Southampton Buildings, London, W.C.2.*

**1950**

3644. Telefonaktiebolaget L. M. Ericsson.—Electric discharge devices. 13th February, 1950. (738482.)

14242. Postmaster General.—Metering in automatic telephone exchanges. 20th September, 1951. (738372.)

**1951**

21606. Standard Telephones & Cables, Ltd.—Printed or otherwise deposited circuits. 15th August, 1952. (738265.)

22186. Standard Telephones & Cables, Ltd.—Electromagnetic deflection arrangements for cathode-ray tubes. 21st September, 1951. (738266.)

**1952**

7770. General Electric Co., Ltd., and Foreman, E. F.—Apparatus including a.c. electric motors of the induction type. 19th June, 1953. (738159.)

7771. General Electric Co., Ltd.—Automatic frequency control of electric oscillation generators. 19th June, 1953. (738160.)

9549. British Tabulating Machine Co., Ltd.—Electronic calculating apparatus. 16th April, 1952. (738269.)

10637. Telefunken Ges., formerly Telefunken Ges. für Drahtlose Telegraphie.—Cathode-ray tubes having ion trapping arrangements. 28th April, 1952. (738270.)

12542. Warmex, Ltd., and Goldstein, A.—Electric indicators for electric switches. 18th May, 1953. (738492.)

13022. General Electric Co., Ltd., Gallizia, E., and Tasker, H. C.—Vapour electric arc converter arrangements. 13th May, 1953. (738273.)

16681. Marconi's Wireless Telegraph Co., Ltd.—Colour television transmission. 23rd June, 1953. (738386.)

19009. Air Reduction Co., Inc.—Inert gas shielded electric arc welding. 28th July, 1952. (738284.)

19152. General Electric Co.—Temperature or pressure responsive electric switches. 29th July, 1952. (738497.)

20018. English Electric Co., Ltd.—Textile spinning machine drives. 7th August, 1953. (738167.)

20284. Sangamo Weston, Ltd. (Sangamo Co., Ltd.).—Thermo-electric converters. 12th August, 1952. (738168.)

20474. General Electric Co.—Luminescent screens. 14th August, 1952. (738285.)

25873. British Insulated Callender's Cables, Ltd.—Metal extrusion presses. 14th October, 1953. (738292.)

26736. Standard Telephones & Cables, Ltd.—Circuit arrangement for the magnetic deflection of the electronic ray in picture tubes used in television receivers. 24th October, 1952. (738297.)

27330. Evershed & Vignoles, Ltd.—Electrical measuring instruments. 26th March, 1954. (738172.)

27624. General Electric Co.—Electroluminescent cells. 3rd November, 1952. (738503.)

28422. English Electric Co., Ltd.—Rectifier equipments and interphase transformers therefor. 5th February, 1954. (738300.)

28563. Staatsbedrijf der Posterijen, Telegrafie en Telefonie.—Alarm device for signalling paper feed faults in tape printers. 12th November, 1952. (738505.)

28653. Junghans Akt.-Ges. and Junghans, H.—Electric time switches. 13th November, 1952. (738174.)

29036. Woods of Colchester, Ltd., and Daly, B. B.—Control of electrically-driven axial-flow fans. 17th February, 1954. (738301.)

29342. General Electric Co.—Multi-cell structures. 20th November, 1952. (738175.)

29519. Young, S. G.—Electrical socket connectors. 23rd November, 1953. (738507.)

29828. Cohen, A. M.—Finger type circuit regulators. 25th November, 1952. (738395.)

29834. Dixon & Co., Ltd., R. G.—Combined pre-set and on-off remote control arrangements of the flexible cable type. 19th November, 1953. (738396.)

31556/7. Standard Telephones & Cables, Ltd.—Electrical key switching and indicating equipment. 12th December, 1952. (738307/8.)

31859. Contactum, Ltd., and Bollinghaus, W.—Electric switch actuating means. 16th December, 1953. (738401.)

32231. Western Electric Co., Inc.—Electron discharge signal delay devices. 19th December, 1952. (738404.)

32435. General Electric Co., Ltd., Friedlander, E. S., and Parton, K. C.—Control systems for electric motors. 15th December, 1953. (738310.)

32655. Compagnie Générale de Télégraphie sans Fil.—Interdigital delay lines for use in travelling wave tubes. 23rd December, 1952. (738405.)

**1953**

1708. United Kingdom Atomic Energy Authority. — Gaseous electric discharge devices. 21st January, 1954. (738182.)

2978. Electric & Musical Industries, Ltd.—Electric amplifiers. 21st January, 1954. (738409.)

3415. British Tabulating Machine Co., Ltd.—Electronic adding circuits. 16th October, 1953. (738314.)

3872. General Electric Co., Ltd., and Booker, F.—Valves. 28th January, 1954. (738315.)

4849. Siemens Electric Lamps & Supplies, Ltd.—Electric lamps for use in flash photography. 19th February, 1954. (738412.)

5297. Henley's Telegraph Works Co., W. T., and Hoban, H. C.—Automatic electric circuit-breakers. 23rd February, 1954. (738191.)

5371. Development, Manufacture & Trade Co., Ltd.—Fault tracing device for use with low voltage electrical circuits. 11th May, 1954. (738192.)

6336. Moulon, J. M.—Negative impedance devices employing transistor amplifiers. 6th March, 1953. (738319.)

6353. Simmons Electrical & Winding Co., Ltd.—Electrical limit switches. 5th March, 1954. (738320.)

7342. British Thomson-Houston Co., Ltd.—Clothes washing machines. 17th March, 1953. (738324.)

8207. Schloemann Akt.-Ges.—Extrusion press for the manufacture of aluminium tubes, more particularly cable sheathings of aluminium. 25th March, 1953. (738514.)

8532. Philips Electrical Industries, Ltd.—Electrical networks. 27th March, 1953. (738417.)

8611. Geigy Co., Ltd., and Howard, D. K.—Production of fluorescent screens. 28th June, 1954. (738196.)

8766. Metropolitan-Vickers Electrical Co., Ltd.—Control of electric traction motors. 22nd March, 1954. (738328.)

8970. Poitras, E. J.—Thermostatic electric switches. 31st March, 1953. (738200.)

9152. General Electric Co.—Transparent fluoride luminescent screens. 2nd April, 1953. (738518.)

9352. Industrial Machinery Co., Ltd.—Thickness gauges employing beta gamma X-rays and the like. 19th February, 1954. (738329.)

10779. Sierra Electronic Corporation.—Electronic power amplifier. 20th April, 1953. (738331.)

10794. Bulgin & Co., Ltd., A. F.—Plunger or push-button operated electric switches. 7th April, 1954. (738422.)

11257. Edison Swan Electric Co., Ltd.—Screening cans for electron-discharge tubes. 15th April, 1954. (738332.)

11361. English Electric Co., Ltd.—Mine winders. 15th April, 1954. (738205.)

12024. Metropolitan-Vickers Electrical Co., Ltd.—Magnetron pulse generators. 12th April, 1954. (738522.)

12464. General Electric Co.—Cam-operated electric switches. 5th May, 1953. (738425.)

12551. Automatic Telephone & Electric Co., Ltd.—Electrical transmission networks. 5th May, 1954. (738523.)

12923. Laurence, Scott & Electromotors, Ltd., Schwarz, B., and Schwarz, K. K.—Excitation systems for alternators. 22nd April, 1954. (738524.)

13117. Electro-Verre.—Device for suspension of electric cables and the like. 11th May, 1953. (738426.)

14161. Wayne Kerr Laboratories, Ltd., and Calvert, R.—Measurement of the dielectric constant and loss factor of dielectrics. 19th May, 1954. (738210.)

15027. Metropolitan-Vickers Electrical Co., Ltd.—Control of a.c. electric motor equipments. 21st May, 1954. (738429.)

15156. Allmanna Svenska Elektriska Aktiebolaget.—Air-blast electric circuit-breaker. 1st June, 1953. (738528.)

15417. Babcock & Wilcox, Ltd.—Vapour generating and superheating units and the control of the temperature of superheated vapour. 4th June, 1953. (738214.)

15604. Telefonaktiebolaget L. M. Ericsson.—Devices for the transmission of signals between an emitting station and a receiving station over a two-conductor line. 5th June, 1953. (738530.)

16403. General Electric Co.—Broad area transistors. 15th June, 1953. (738216.)

16878. Welwyn Electrical Laboratories, Ltd., and Whitfield, E. H.—Electrical resistors. 11th June, 1954. (738280.)

17059. General Electric Co., Ltd., and Bayliss, A. J.—Electric counting apparatus. 4th June, 1954. (738218.)

17302. Foxboro Co. — Automatically balanced bridge measuring system incorporating transistor amplification. 22nd June, 1953. (738343.)

17358. E. M. P. Electric, Ltd.—Electric fuses. 7th October, 1953. (738344.)

17933. Westinghouse Brake & Signal Co., Ltd., and Newman, R. A. A.—Circuits for the supply of d.c. from an a.c. source. 11th June, 1954. (738222.)

18478. Sperry Gyroscope Co., Ltd.—Method of making insulated electrical conductors. 3rd June, 1954. (738536.)

21330. Goodrich Co., B. F.—Electrically-heated protective covering for aircraft. 31st July, 1953. (738444.)

22139. General Electric Co.—Semi-conductor p-n junction units. 11th August, 1953. (738231.)

23434. Western Electric Co., Inc.—Apparatus for coating cores by extrusion. 25th August, 1953. (738354.)

24419. Radio-Industrie.—Short distance radio navigation systems. 3rd September, 1953. (738450.)

25636. General Electric Co.—Phase balancing systems. 16th September, 1953. (738453.)

25806. Pirelli-General Cable Works, Ltd., and Arman, A. N.—Electric cables. 7th July, 1954. (738239.)

*(Continued at foot of next page*

# CONTRACT INFORMATION

## Accepted Tenders and Prospective Electrical Work

### CONTRACTS OPEN

*Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.*

**Angola.**—26th September. Ports, Railways and Transport Services. Electric power and light installations. (E.S.B. 17908/55. Ten/15296.)*

**Antrim.**—29th September. County Education Committee. Electrical installation in extension to Lisburn Technical School. J. McCandless, consulting engineer, 6, Murray Street, Belfast.

**Australia.**—21st October. Brisbane Electricity Department. Medium and low voltage air-break switchgear. (E.S.B. 17998/55. Ten/15289.)*

27th October. Western Australian Government Tender Board, Perth. Steam raising plant. (E.S.B. 17944/55. Ten/15297.)*

State Electricity Commission of Queensland. 132 kV overhead transmission line. Closing date for tenders postponed to 19th October. (E.S.B. 13922/55. Ten/14440A.)*

4th October. N.S.W. Electricity Commission, Sydney. Nine 60 MVA, 132 kV transformers for Warringah, Bankstown and Guildford substations. (E.S.B. 18247/55. Ten/15344.)*

**Ayr.**—County Council. Street lighting equipment. (See this issue.)

**Belfast.**—22nd September. Northern Ireland Hospitals Authority. Electrical services in Moyle Hospital, Larne, Co. Antrim. Chief engineer to the Authority, Victory Buildings, 44/6, Queen Street, Belfast.

15th September. City Council. Electrical installation in Mersey Street Primary School. Education architect, 40, Academy Street, Belfast.

29th September. Renewal of complete electrical installation in the Donegall Road Branch Library. J. McCandless, consulting engineer, 6, Murray Street, Belfast.

**Brentford and Chiswick.**—23rd September. Borough Council. Mercury vapour lighting in Brentford High Street, Kew Bridge Road, Ealing Road, Brentford Half Acre, Boston Road, Boston Manor Road and Windmill Road. Borough engineer, Town Hall, Chiswick, W.4.

**Derby.**—27th September. Corporation. Sodium lighting units for trunk road A.6. (See this issue.)

**Dublin.**—20th September. Corporation. 1,000 fuse boxes for Public Lighting Department. Finance Department, City Hall.

**Egypt.**—Cairo Electricity and Gas Administration. Underground and submarine cable. (E.S.B. 18230/55. Ten/15305.)*

22nd September. 6·6/3·3 kV transformer substation at Helwan. (E.S.B. 18310/55. Ten/15320.)*

**Iran.** — 22nd September. Procurement Office, United States Operations Mission to Iran, Sepah Building, Tehran. Signal and communication equipment. (E.S.B. 17770/55. Ten/15236.)*

**New Zealand.**—30th September. Dunedin Electricity Department. 11/6·6 kV fuse switches and ring main switchfuse units. (E.S.B. 18204/55. Ten/15300.)*

**Portugal.**—30th September. Administrative Commission for New University Buildings, Lisbon. Emergency generating plant, electrical installation, bells, clocks, telephones, air conditioning, etc. (closing date postponed from 30th August). (E.S.B. 16265/55. Ten/14846A.)*

**Portuguese East Africa.**—29th September. Commando Militar de Angola, Quartel General, Luanda. Accumulators and portable charging plants. (E.S.B. 17981/55. Ten/15246.)*

**Solihull.** — 23rd September. Borough Council. Lighting installation in trunk road A.41. (See this issue.)

**South Africa.**—14th September. Union Tender and Supplies Board, Pretoria. Telephone cable. (E.S.B. 18348/55. Ten/15318.)*

21st September. Stores Department, South African Railways. Electric cable. (E.S.B. 18051/55. Ten/15258.)* Battery charging equipment. (E.S.B. 17532/55. Ten/15253.)*

19th October. Cape Town Electricity Department. 66 kV switchgear and accessories. (E.S.B. 18380/55. Ten/15329.)*

**Syria.**—25th September. Director de l'Irrigation et des Forces Hydrauliques, Damascus. Pumping equipment for water wells. (E.S.B. 18363/55. Ten/15354.)*

**Turkey.**—Eti Bank, Ankara, Turkey. Transformers and switchgear. (E.S.B. 17917/55. Ten/15263.)*

1st October. N.A.T.O. Infrastructure Contracts. Twenty-seven diesel generator sets for nine radar stations. (E.S.B. 1071/55. Ten/15342.)*

**Tyldesley.** — 30th September. U.D.C. Dismantling of existing electrical installation and the complete re-wiring of the Town Hall. U.D.C. surveyor, P.O.Box No. 7, Town Hall.

**Uruguay.**—6th October. Administracion General de las Usinas y los Telefonos del Estado, Montevideo. L.c. telephone cable. (E.S.B. 17954/5/55. Ten/15259/79.)*

**West Bridgford.**—5th October. U.D.C. Lighting installation, Melton Road. (See this issue.)

**Whitley Bay.**—Town Council. Electrical re-wiring of 50 houses in Kingsley Avenue and Belvedere Avenue. E. Roberts, borough engineer, Municipal Buildings.

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

### NEW PATENTS (*concluded from previous page*)

26054. Squires, F., Walker, K. G., and Bellis, G.—Insulator for making electrical connections. 20th September, 1954. (738544.)

26359. Welwyn Electrical Laboratories, Ltd., and Whitfield, E. H.—Resistors. 3rd September, 1954. (738240.)

26495. Metallges. Akt.-Ges.—Apparatus for the electrical precipitation of suspended particles from gaseous fluids. 25th September, 1953. (738241.)

27956. Felten & Guilleaume Carlswerk Akt.-Ges.—Arrangement for supervising, remote-controlling, or locating faults in unattended intermediate amplifiers affected by transmission faults. 12th October, 1953. (738464.)

28858. Siemens & Halske Akt.-Ges.—Electro-magnetic apparatus for railway traffic control systems. 19th October, 1953. (738466.)

29301. Allmanna Svenska Elektriska Aktiebolaget.—High voltage electric circuit-breaker with a plurality of series connected breaking gaps. 23rd October, 1953. (738467.)

30306. Cardelli, M.—Single-phase commutator motor. 3rd November, 1953. (738552.)

31578. Bendix Aviation Corporation.—Automatic gain control circuits. 13th November, 1953. (738553.)

35780. General Electric Co.—Fluid-cooled electrical apparatus. 23rd December, 1953. (738365.)

35826/7. Compagnie Générale de Télégraphie sans Fil.—Space-charge wave tubes. 23rd December, 1953. (738256/7.)

36236. General Electric Co.—Devices for measuring currents in polyphase rectifying systems. 30th December, 1953. (738367.)

36357. General Electric Co.—Electric contact devices of the slip ring kind. 31st December, 1953. (738560.)

### ORDERS PLACED

**Birkenhead.**—Corporation. Electrical installation in Woodchurch Road Primary School (£2,829).—J. McKenzie.

**Glasgow.**—Water Committee. Electrical installation in tunnel under the River Clyde, and in concrete pipe culvert through Barclay Curle's shipyard (£5,516).—Malcolm & Allan.

Education Committee. Electrical work at the Primary Schools at Castlemilk (£8,228).—J. B. Meiklejohn (in lieu of tender withdrawn).

**Isle of Ely.**—County Education Committee. Electrical installation work at the Isle of Ely College of Further Education and Horticultural Institute (£5,230).—Ely Electrical Co.

**London.**—St. Marylebone General Purposes Committee. Recommended. Renewal of electrical wiring in the Town Hall (£7,343).—Higgins & Cattle.

**Maidstone.**—Housing Committee. Recommended. Electrical installations in 38 houses and flats on the Shepway estate (£1,201).—South Eastern Engineering Co.

### WORK IN PROSPECT

*Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors*

**Aldershot.**—Parish hall for Holy Trinity Church; Henry F. Hepworth, architect, 46, Jubilee Road.

**Atherton.**—Further 80 houses and 40 flats, Hag Fold estate; U.D.C. surveyor.

**Barnard Castle.**—Houses (32), at Cockfield, for the R.D.C.; J. Lawton, architect, 45, Galgate, Barnard Castle.

**Barnsley.**—Works extensions; Qualters & Smith, Ltd., Crookes Street Engineering Works.

**Batley.**—Houses and bungalows (158), proposed as development of Purlwell estate; borough surveyor, Hanover Street.

**Belper.**—Factory, Derby Road; Adshead, Ratcliffe & Co., Ltd., Campbell Street.

**Beverley (Yorks).**—52 dwellings at Swinemoor estate for B.C.; Stepney Contractors, Ltd., Grovehill Road.

**Billingham-on-Tees.**—Apprentices training school for Imperial Chemical Industries, Ltd. (£100,000); Leslie and Co., contractors, Woodland Road, Darlington.

**Blackpool.**—Three-storey block of flats, Talbot Road; John Gregson & Son, 3, Newhouse Road, Marton, Blackpool.

**Bollington (Ches.).**—R.C. church; T. Campion & Son, Ltd., Devonshire Street, Ardwick, Manchester.

**Bootle.**—Laundry, Park Lane, Netherton, for Silvermere Cleaners, Ltd.; Roberts & Sloss, Ltd., 23, Baker Street, Liverpool.

**Bristol.**—Fifteen-storey block of flats, Barton Hall estate; city architect.

**Crawley.**—County buildings (£219,300), for West Sussex C.C.; F. R. Steele, county architect, County Hall, Chichester.

**Croydon.**—Offices; H. W. Wallace & Co., Ltd., 172, St. James Road.

**Dewsbury.**—Dwellings (156), at Field Lane site; Fell Construction Co., Ltd., Wakefield.

**Eccles.**—Further 134 houses and 12 flats at Brookhouse estate for T.C.; Bower Moffatt & Co., Ltd., Cheetham, Manchester.

**Essex.**—Laboratory block at County High School, Braintree (£31,700), and extensions at Kingswood Secondary School, Dagenham (£13,500); H. Conolly, county architect, County Hall, Chelmsford.

**Gateshead.**—Workshop, showroom and offices near East Street; W. and T. Avery, Ltd., Prudhoe Street, Newcastle-on-Tyne.

**Glasgow.**—Houses (246), Castlemilk; city architect.

Works extensions; McCallum & Craigie, Ltd., 57, Wellshot Road.

**Gosforth (Northumberland).**—Houses (28), Church Road, for U.D.C.; A. Robertson and Co., builders, East Park View, Blyth.

**Hayes.**—Houses and flats (59), Willow Tree estate, Yeading Lane; borough engineer, Town Hall, Southall.

**Hinckley.**—Extensions to factory of Burgess Products, Ltd. (£65,000); George Calverley & Sons, Ltd., builders, Leicester.

Flats, King George's Way; borough architect.

**Hornsey.**—Retail store with offices, The Broadway and Crouch Hall Road; F. W. Woolworth & Co., Ltd., 311, Oxford Street, London, W.1.

**Hull.**—Works and offices, Waverley Street; United Brass & Copper Works, Ltd., 25, Osborne Street.

**Ilford.**—Pumping station (£100,000), Roden Street; borough engineer.

**Keynsham.**—Houses (120), Park West estate; U.D.C. surveyor, Council Offices, Keynsham, Bristol.

**Lancaster.**—Departmental store, Market Street; Littlewood Mail Order Stores, Ltd., 152a, London Road, Liverpool.

**Leeds.**—Two-storey factory and offices at Parkside, Hunslet; Porterprint, Ltd., printers, Porterprint House, Easy Road, 9.

Extensions to grammar school; G. Alan Burnett, architect, 76, Albion Street.

**Lincolnshire.** — Schools at Holbeach (£165,717) and Long Sutton (£199,397), for Holland C.C.; county architect, Boston.

**London.**—Operating theatre suite, Dulwich Hospital; South East Metropolitan Regional Hospital Board, 9, Hallam Street, W.1.

Office block, Lambs Conduit Street, Holborn; H. Fairweather & Co., Ltd., builders, Hyde Works, St. James's Lane, N.10.

Laboratories; Wm. Harland & Sons, Ltd., Phipps Bridge Road, S.W.19.

**Luton.**—Health centre, Farley Hill estate; county architect, Shire Hall, Bedford.

**Macclesfield.**—Wool spinning mill, Hulley Road, for Rochdale Carpet Co., Ltd.; R. B. Turner, architect, 180, Oxford Road, Manchester.

**Manchester.**—New buildings at Hendham Vale Works for Small & Parkes, Ltd.; Reynolds & Scott, architects, 9, Albert Square, Manchester.

Works, stores and offices, Trafford Park Road; Schori Metallising Process, Ltd., Avenue Works.

**Mansfield.**—Dwellings (105), at Ladybrook estate, for B.C.; Hy. Boot & Sons (Reema), Ltd., Banner Cross Hall, Eccleshall Road South, Sheffield, 11.

**Margate.**—Shops and offices, High Street; Shop Development Group of Companies, 12, St. George Street, Hanover Square, London, W.1.

Bungalows (42), Epple Road, Birchington; Kings & Sons, Ltd., Station Approach.

**Middlesbrough.** — Additions to X-ray department at General Hospital (£20,000); Newcastle Hospital Board, Benfield Road, Newcastle-on-Tyne.

C. of E. church, The Greenway, Thorntree estate; W. E. Haslock, architect, 143, Albert Road.

**Newcastle-on-Tyne.**—Proposed outpatients' department at Royal Victoria Infirmary (£150,000); Turley and Williamson, architects, 46, Jesmond Road.

**Nonington (Kent).**—Hostel block, gymnasium and other buildings at College of Physical Education (£100,000); Kent county architect, Springfield, Maidstone.

**Northleach.**—Houses and bungalows (56), Andoversford; R.D.C. surveyor, Council Offices, Northleach, Glos.

**Nottinghamshire.** — County secondary schools at Balderton Grove, East Leake, Mansfield, Misterton and Radcliffe-on-Trent, and county secondary technical schools at Sherwood Hall, Mansfield, and Park, Eastwood Hall; county architect, Shire Hall, Trent Bridge, Nottingham.

**Peterborough.**—Houses (84) and flatlets, Walton estate; city engineer, Town Hall.

**Pewsey.**—Houses (83); surveyor, Rural Council Offices, Pewsey, Wilts.

**Plymouth.**—Factory, Ernesettle; Clatworthy (1944), Ltd., Restola Works, Sutton Road.

**Portsmouth.**—Offices; Hampshire Building Society, 107, Commercial Road.

Houses (118), Westleigh, Leigh Park; J. Parkin, city engineer, 1, Clarence Parade, Southsea.

**Rochdale.**—Factory at Fieldhouse Mills; John Bright & Bros., Ltd., cotton manufacturers, Fieldhouse and Moss Mills.

**St. Helens.**—Houses (61), Hayes Street, Thatto Heath; M. Ward, borough engineer, Town Hall.

**Sheffield.**—Industrial research station, East Bank Road; British Steel Founders' Association, Research and Development Division, Broomgrove Lodge, Broomgrove Road, 10.

**Shildon.**—Houses (36) and aged people's bungalows (10); U.D.C. surveyor.

**Slough.**—Chest clinic and other building works at Upton Hospital (£31,000), for North West Metropolitan Regional Hospital Board; regional architect, Sheffield House, Sheffield Street, London, W.C.2.

**Spennymoor.**—Houses (30), Byers Green, for U.D.C.; Gray and Partner, architect, Camden Street, North Shields.

**Stafford.**—Church, Tillington Hall estate; Bernard A. Miller, architect, 39, Bluecoat Chambers, School Lane, Liverpool.

**Staines.**—Houses (80), Convent Road, Town Tree Road, and Exeford Avenue and St. Michael's Road, Ashford, for U.D.C.; surveyor, 240, London Road, Staines, Middx.

**Stockport.**—Houses (36), at Naseby Road, Reddish; borough surveyor.

**Stretford.**—C. of E. church at Barton Road; Wm. Thorpe & Son, Ltd., Chester Road, Cornbrook, Manchester.

**Strood.**—Factory on twelve-acre site; Metal Box Co., Ltd., The Langham, Portland Place, London, W.1.

**Surrey.**—Classrooms, kitchen and dining room at Glyn School, Ewell (£36,000) and county primary school, Ashtead (£35,000); J. Harrison, county architect, County Hall, Kingston-on-Thames.

**Sutton Coldfield.**—80 flats, bungalows and houses proposed, in the centre portion of the Falcon Lodge estate; borough surveyor.

**Thornaby.**—Home for 40 old people; county architect, Northallerton.

**Totnes.**—Municipal offices, cinema-theatre, etc., proposed on the civic hall clearance site; borough surveyor, Walrond House, Fore Street.

**Wallsend.**—Houses (104), Low Willington Farm estate; Builders. J. Armstrong, Macnamara Road, Wallsend (32 houses), and J. H. James, Archer Street, Wallsend (72 houses).

**Warrington.**—Office block and canteen at Battersby Road, for British Road Services; J. Gerrard & Sons, Ltd., Swinton, near Manchester.

**Wellingborough.**—Houses (50), Northampton Road estate; R. Kilby, U.D.C. surveyor, Council Offices, Swanspool.

**Wolverhampton.**—232 flats and houses, with central boiler house, calorifier rooms, stores, communal laundries, etc., as first instalment of Dale Street re-development; borough engineer, Town Hall.

**Worthing.**—Bungalows (51), Brougham Road and Meadow Road; M. Rainsford, Fletcher & Partners, architects, 13, Ambrose

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# *NEXT WEEK'S EVENTS*

*Organizers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates do not clash with others already arranged*

### Thursday, 1st September, to Thursday, 15th September

LONDON.—Olympia. Engineering, Marine & Welding and Foundry Trades Exhibition.

### Monday, 12th September

BIRMINGHAM.—Grand Hotel, 6.15 p.m. Birmingham Electric Club. Presidential Address, by H. C. Fox.

LONDON.—St. Ermins Hotel, Caxton Street, 7 p.m. A.S.E.E. Central London Branch. "Television—Modern Practice."

MANCHESTER.—Reynolds Hall, College of Technology, Sackville Street, 7.15 p.m. Institution of Production Engineers, North Western Region. "The Gas Turbine Locomotive," by P. E. Stock.

WEMBLEY PARK.—The Century Hotel, Forty Avenue, 7.30 p.m. A.S.E.E. North-West London Branch. Chairman's reception.

### Tuesday, 13th September to Friday, 16th September

FOLKESTONE.—Association of Public Lighting Engineers. Annual conference and exhibition.

### Tuesday, 13th September

LONDON.—Connaught Rooms, 12.30 for 1 p.m. Electrical Industries Club. Presidential address by Leslie C. Gamage, "Some Thoughts on Export Trade."

MANCHESTER.—Engineers' Club, Albert Square, 7.15 p.m. Incorporated Plant Engineers, Manchester Branch. Chairman's "At home."

### Wednesday, 14th September

BIRMINGHAM.—Chamber of Commerce, New Street, 7.15 p.m. A.S.E.E. Birmingham Branch. "Relays and Automatic Control in Industry," by Dr. W. L. Stern.

DUNDEE.—New Imperial Hotel, 15, Tally Street, 7.30 p.m. Institution of Production Engineers, Scotland Region. "The Practical Application of Production Engineering Research," by Dr. D. F. Galloway.

WIMBLEDON.—Guild House, 32, Worple Road, 8.15 p.m. A.S.E.E. South-West London Branch. "Industrial X-Rays," by F. L. Veale.

YORK.—The Shambles Café, 7.15 p.m. A.S.E.E. York Branch. "Miniature Circuit-Breakers," by F. Grant.

### Thursday, 15th September

WATFORD.—Clarendon Hotel, Station Road, 8.15 p.m. A.S.E.E. Watford Branch. "Electricity in the Aircraft Industry," by E. Wade.

### Saturday, 17th September

OXFORD.—Y.M.C.A., 10, George Street, 6.30 p.m. A.S.E.E. Oxford Branch. "Electric Heating, Heat Pumps and Hot Water from the Fridge," by A. W. Bates.

SHEFFIELD.—A.S.E.E. Sheffield Branch. Visit to Ladybower Dam and Yorkshire Bridge filters.